RADIO HANDBOOK

Portland, Oregon

November 23, 1942

R-6 Supplemental List No. 12

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New & Revised Pages	Superseded Pages
C13.9, Type K, Model AB	Lemon yellow divider sheet, Pages 30 and 30A	None-new material
C13.10, Type KU-R, Model A	Page 13A	" " "
C13.11, Type KU-T, Model AA	Lemon yellow divider sheet, Pages 17 and 17A	" " "

Pen and Ink Corrections:

C13.1, Type SPF, All Models
Make the following changes on page 16, Model AA:
Symbol No. L101 and L102: Change the type No. 32-618 to 32-618A
" " L103 and L104: Change type No. 32-620 to 32-619
" " L104 and L106: Change type 32-619 to 32-620

C13.1, Type SPF, Model AF
Page 35, paragraph 2, first line:
Delete the words "register on" to "resistor 15,000 ohms across"
Second line:
Change "UT4" to "VT-4" and delete "15,000 ohms".

C13.9, Type K
Insert on orange cover sheet (for entire section):
Model AA Nos. 40 to 55 inc.
Model AB Nos. 56 to _______

Insert in blank space on orange divider sheet for Model AA "55 inc."

C13.10, Type KU-R, Model A
Page 3, paragraph 1.0:
Second line: Change 50 kc to 40 kc

Page 5:
Add on end of second line on page: "On serial No. 52 and higher these trimmers are accessible by removing the unit from its case."

C13.10, Type KU-R, Model A (continued)
Page 8, paragraph 2.21:
Third line: Change 50 kc to 40 kc

Page 13, paragraph 23:
Seventh line: Delete the words "a picture" and add "the".

*Page 23, Parts List, add to Symbol R-113:
"From Serial No. 91 on the rating of 75,000 ohms has been decreased to 50,000 ohms."

*Page 25, Parts List, add to Symbol R-147:
"From Serial No. 91 on the rating of 200,000 ohms has been decreased to 100,000 ohms."

*Page 25, Parts List, add to Symbol R-153:
"From Serial No. 91 on the rating of 1 megohm has been increased to 3 megohms."

NOTE: Also make the above three changes on Fig. 2.62, the schematic diagram.

C13.11, Type KU-T, Model A
Insert on orange cover sheet:
First line: Model A 1 to 12 inc.
Second line: Model AA 13 to _______

C13.11, Type KU-T, Model AA
Fig. 2.62A: Change the screen suppressor resistor for VT-3 from R-16, 50 ohms, to R-17, 50 ohms.

Portland, Oregon

September 25, 1942

R-6 Supplemental List No. 11

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New & Revised Pages	Superseded Pages
C13.1, Type SPF, Model AF	Page 35	None-New Material
C13.10, Type KU-R	Pages 1 to 28	None-New Material

Pen and Ink Correction:

C13.1, Type SPF, Model AE — Buff colored cover sheet - Insert number 966 in blank space

An employee separated from the rolls on the first day of a quarterly promotion period may not receive a promotion, i.e., January 1, April 1, July 1 and October 1.

An administrative error in granting or failing to recommend promotion will be corrected, effective retroactively to date of error.

Promotions during Military Furlough

Unless the required civilian service was completed previous to furlough, promotions will not be made on the quarter while employee is in military furlough status. If in annual leave status, even though concurrently with military pay, action will be taken. Upon return to the rolls as a civilian employee, formal action will be taken to adjust the salary rate to that which would have applied had the veteran been eligible for promotion at each promotable period during his absence.

Meritorious Promotions

Recommendations for salary increases within grade of not more than one step may be made by field officers to the Regional Forester at any time the circumstances warrant, supported by statement of facts warranting the action. Illustrative examples are: (a) display of outstanding initiative

W.O.
E.W. Loveridge

Portland, Oregon

March 9, 1942

Supplemental List R-6 No. 1

R-6 SUPPLEMENT TO RADIO HANDBOOK

Forest Officer:

The following R-6 supplemental pages for the Radio Handbook are transmitted herewith for insertion in your copy at the end of Part A:

Section	New & Revised Pages	Superseded Pages
A2.0	PP. 13a & 13b	None - new material

930094

Portland, Oregon

October 1, 1941

R-6 Supplemental List No. 10

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New & Revised Pages	Superseded Pages
0.0 Index	Pages i, iii, iiii	Pages i, iii, iiii
C9.200	Page 31	Page 31
C9.203	Pages 33 and 35	Pages 33 and 35
C9.204	Page 36	None - New Material
C9.204a	Pages 36a, 36b, 36c	" " "
C9.205	Page 36d	Page 35c (See correction letter)
C9.206	Page 36e	Page 35d (See correction letter)
C13.1, Type SPF, Model AA	Pages 13, 15, 16, 17, 18, 19, 20, 21, 22	Pages 13, 15, 16, 17, 18, 19, 20, 21, 22
Model AE	Page 33	Page 33
	Page 34	None - New Material
C13.3, Type M, Model D	Page 43	Page 43
	Page 48	None - New Material
C13.7, Type T	Orange Cover Sheet (Models CA to DB)	Orange Cover Sheet (Models CA to D)
C13.7, Type T, Model D	Pages 27a, 72, 73, 74, 75	Pages 27a, 72, 73, 74, 75
	Page 84	None - New Material
Models DA & DB	Buff-Colored Cover Sheet	None - New Material
	Page 85	" " "
Model DB	Page 86	" " "
C13.8, Type I, Model D	Page 65	Page 65
	Page 70	None - New Material
C13.9, Type K, Model A	Page 21	Page 21
	Page 27a	None - New Material

Correction Letter

Note: Section C13.10, Type KU-R, listed in the Index will be issued at a later date.

U. S. FOREST SERVICE
R-6

0
RADIO
General

Portland, Oregon

October 1, 1941

Corrections to be made with pen and ink
on Supplemental List No. 10, Radio Handbook

Sec. C9.204, C9.205 & C9.206

Pages 35c and 35d - delete these pages

Sec. C13.3, Type M, Model D

Add the following items to Contents on Page 19:

2.7	Additional Data	Page 48
2.71	Resistance in Meter Switches	" 48

Sec. C13.7

Buff-colored cover sheet, fill in to read:

Nos. 310 to 397 Inc.

Sec. C13.7, Type T, Model D

Page 71, second item:

Change description of R102 to read 0.1 megohm in place of 0.2 megohm

Sec. C13.8, Type I, Model D

Add the following items to Contents on page 34:

2.7	Additional Data	Page 70
2.71	Resistance in Meter Switches	" 70

Sec. C13.9, Type K, Model A

Add the following item to Contents on Page 1:

2.72	Resistance in Meter Switch	Page 27a

Portland, Oregon,

June 23, 1941.

R-6 Supplemental List No. 5.

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy.

Section	New & Revised Pages	Superseded Pages
C13.11, Type KU-T Model A	Service Data Sheet 1 - 16 inc.	None - new material

The above Supplemental List No. 5 was originally intended to be sent out under date of March 25, 1940 but has been delayed pending receipt of additional material.

Page 17, 2.63 Photodiagram, listed in the Table of Contents, is not yet available and will be sent out later.

U. S. FOREST SERVICE
R-6

O
RADIO
General

Portland, Oregon,

June 10, 1941.

Corrections to be made with pen and ink
on Supplemental List No. 9, Radio Handbook

Sec. A4.9

Page 7a, add "(Discontinued)" to title line, thus:

Sec. A4.9 Type S Radiophone Transceiver (UHF) (Discontinued)

Sec. C9.206

Page 36, delete this page.

Sec. C12.301, Type A Test Set

Orange cover sheet, fill in serial numbers as follows:

Model A	Nos.	1	to	3	inc.
AA		4		13	
AB		14		16	
B		17			

Sec. C12.302, Type D Test Set

Page 3, "Type" designation for L201 should be T-13C27 instead of T-14C27

Sec. C13.1, Type SPF

Orange cover sheet, fill in serial numbers as follows:

Model	AA	Nos.	265	to	480	inc.
	AB		481		743	
	AD		744		903	
	AE		904			

Sec. C13.1, Type SPF, Model AD

Buff colored cover sheet, fill in to read:

Nos. 744 to 903 inc.

Sec. C13.1

Page 21, 1st item:
Replace 15" with 30"

Sec. C13.5, Type S, Model A

2.59, Miscellaneous, change description of socket items to read as follows: (page 8)

1 Socket, 5-prong linen bakelite wafer type; Bud, Cinch or equivalent.
1 Socket, 4-prong National Type XC-4

Sec. C13.7, Type T, Model D

Page 74, 2.59 Miscellaneous, 4th item:
Change type designation from D-5-F to D5J-9

Sec. C13.7, Type T, Model D

Page 75, last item:
Change quantity from 3 to 4

Sec. C13.7, Type T, Model D

Page 82:
Mark drawing, "Serial nos. 1 to 5, inclusive."

M. O. E. W. Foveridge

Portland, Oregon,

June 10, 1941.

R-6 Supplemental List No. 9.

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New & Revised Pages	Superseded Pages
A4.12	Pages 8 and 8a	Pages 8 and 8a
C12.301, Type A Test Set Models AB and B	Service Data Sheet Pages 17 to 19	None - new material " " "
C13.1, Type SPF, Model AE	Service Data Sheet Page 33	" " " " " "
C13.7, Type T, Model D	Page 83	" " "
C13.12, Type SX, Model A	Service Data Sheet Pages 1 to 19	" " " " " "
C13.13, Type SXA, Model A	Service Data Sheet Pages 1 to 6	" " "

Correction Letter

W.O. Loveridge

Portland, Oregon,

November 6, 1940.

R-6 Supplemental List No. 8.

SUPPLEMENT TO U S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New & Revised Pages	Superseded Pages
0.0, Index	iii and iiii	iii and iiii
C12.302, Type D, Model A	1 - 7	-
C12.303, Type 245-R Battery Tester	Service Data Sheet 1 - 4	-
C13.1, Type SPF, Model AD	28, 32	28
C13.7, Type T, Model D	27a, 79 - 82	-
Revised List of Manufacturers	I - IV	I - V

Correction Letter

FOREST SERVICE
R-6

O
RADIO
General

Portland, Oregon,

November 6, 1940.

Corrections to be made with pen
on Supplemental List No. 8, Radio Handbook

Sec. C12.301, Type A Test Set

Orange cover sheet, revise to read as follows:

Model A	Nos.	1	to	4	inc.
Model AA	Nos.	5	to	13	inc.
Model AB	Nos.	14	to		inc.

Sec. C13.1, Type SPF, Model AA

Page 15, add after 8th item:
C-129 Filament Bypass .1 mf Solar MP-4147 Note 8

Page 20, Note 11, add:
Western Electric Type 247808 phenol fibre grid is used with Type F-1 microphone.

Page 20, 11th item:
Under "Type", substitute 98304 instead of 89272

Page 21, 1st item:
Under "Type", substitute 98304 instead of 89272

Sec. C13.1, Type SPF, Model AD

Page 30, insert after "Microphone" (next-to-last) item:
Microphone Cover Grid Western Electric Type 247808 phenol fibre grid

Sec. C13.3, Type M, Model D

Page 44, 5th item:
Under "Type", substitute 98304 instead of 89272

Sec. C13.5, Type S, Model A

Page 7, add after 6th item:
C7 .0005 mfd. Fixed Mica Aerovox Type 1466, or Solar Type MT-1322

Page 8, "2.59, Miscellaneous", 1st item, 2nd sentence, revise to read:
Western Electric Type F-1 with special case and W.E. Type 247808 Phenol Fibre Grid used in serial nos. S-740 and higher.

Page 8, "2.59, Miscellaneous", 12th item:
Substitute 2/0 instead of Z/o

Sec. C13.6, Type SV, Model A

Page 11, 1st item, 2nd sentence, revise to read:
Western Electric Type F-1 with special case and W.E. Type 247808 phenol fibre grid used in serial nos. SV-170 and higher.

Page 11, 9th item:
Substitute 98304 instead of 89272.

Page 11, 20th (next-to-last) item:
Substitute 2/0 instead of Z/o

Sec. C13.7, Type T, Model D

Page 74, "2.59, Miscellaneous", add to 3rd item as follows:

1	Microphone	Stromberg-Carlson	24562
		Western Electric	F-1 with W.E. Type 247808 phenol fibre grid (note 2)

Page 74, "2.59, Miscellaneous", 7th item:
Under "Type", substitute 98304 instead of 89272

Page 74, add footnote:
Western Electric Type F-1 microphone used on serial nos. approx. T-356 and higher.

Sec. C13.8, Type I, Model D

Page 66, 9th item:
Under "Type", substitute 702A for 702

Sec. C13.9, Type K, Model A

Page 22, 7th item:
Under "Type", substitute 98304 instead of 89272

Sec. C13.9, Type K, Model AA

Page 28, 2nd paragraph, insert after 2nd sentence:
Also "Service Manual","Motorola Electric Automatic Tuner", Galvin Mfg. Co. Form S-7-R.

See all

U. S. FOREST SERVICE
R-6

O
RADIO
Radio Handbook

Portland, Oregon,

June 1, 1940.

Forest Officer:

Please make the following corrections in your copies of the Forest Service Radio Handbook:

Sec. A3.0, Page 3, Service Policies - 3rd line - change "GA-17" to "GA-I7"
5th " " "GA-17" to "GA-I7"

Sec. A4.0, Page 3 - 11th line, change "20,000" to "6,000".
12th " insert after "frequency" "equipment".

Sec. A4.4, Page 5 - 1st paragraph, delete "and employing a communication type receiver".

Sec. A4.12, Page 8, 2nd paragraph, change Types "T, S, A, and U" to "T, S, SV, KU, U, and A".

Sec. A4.13, Page 8a, 2nd paragraph, change type "I" to "K".

Sec. A5.0, Page 10, 2nd column, 2nd paragraph, change "of" to "or".

Sec. C9.102, Page 25, 3rd line, change "Insulators are National type AA6" to "A tandem pair of strain insulators, such as Johnson type 30, are used at each end."

Sec. C9.104, Page 27, 1st line, change type "I" to "K".
2nd paragraph, change type "I" to "K".

Page 28, 2nd paragraph, 1st line, change "25" to "20".

Sec. C9.105 Page 28, 2nd paragraph, 11th line, change type "I" to "K", and "50" to "40-50".

Sec. C9-202, Page 31, 2nd line, insert after "Type T Radiophone" "Models CA, CB, and CC".

Sec. C11.1, Page 44, 2nd column, change "Radio, Ltd., 7460 Beverly Blvd.", to "The Editors of Radio, 1300 Kenwood Road, Santa Barbara, Calif."

Sec. C12.103, Page 45, add "See Sec. C12.301".

Journal 3-9-41

Portland, Oregon

July 26, 1940

R-6 Supplemental List No. 7

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following Supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New & Revised Pages	Superseded Pages
C8.0	23 - 23a	23
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C9.206	35d	-
C9.3	37	37
C10.1	39	39
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C13.1, Type SPF, Model AA	13-24	13-24
C13.1, Type SPF, Model AB	26	26
C13.5, Type S, Model A	4,7,8,9,	4,7,8,9
C13.6, Type SV, Model A	1,5,5a,6,7,8,9, 10,11,12,14,15,16	1,5,6,7,8,9,10,11,12,
C13.7, Type T, Model D	40,74	40,74
C13.9, Type K, Model A	1,22,23,26,27	1,22,23,
C13.9 Type K, Model AA	Service Data Sheet 28,29	-

Correction letter

RECORD OF RECEIPT AND INSERTION OF AMENDMENTS AND ADDITIONS TO RADIO HDBK

Amendment Number	Date of Amendment	Date of Insertion with Signature	Amendment Number	Date of Amendment	Date of Insertion with Signature
1 ✓	10-16-39	12-20-39 M.A.	26		
2 ✓	10-16-39	1-15-40 M.A.	27		
3 ✓	1-10-40	3-5-40 MA.	28		
4 ✓	2-1-40	3-14-40 MA.	29		
5 ?			30		
6 ?			31		
7 ✓	7-26-40	8-12-40 MA.	32		
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9			34		
10			35		
11			36		
12			37		
13			38		
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20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Portland, Oregon

July 24, 1940

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New Pages	Revised Pages	Superseded Pages
C13.1, Type SPF, Model AA	25a	-	-
C13.1, Type SPF, Model AD	28-31	-	-

Note: Amendment No. 5 is being held for later distribution.

Forest Service
R-6

O
RADIO
General

Portland, Oregon

April 1, 1940

Corrections to be made with pen
on Supplemental List No. 6, Radio Handbook.

Sec. C13.1, Type SPF (Service Data Sheet) -

Orange sheet, second and third lines should read:

Model AB	Nos. 481	to	743	Inc.
Model AD	Nos. 744	to		Inc.

Sec. C13.1, Type SPF, Model AB (Service Data Sheet)

Light yellow sheet, last line should read:

Nos. 481 to 743 Inc.

3101 W.O. - E.W. Loveridge

Portland, Oregon

May 22, 1940

R-6 Supplemental List No. 4

SUPPLEMENT TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New Pages	Revised Pages	Superseded Pages
C12.402	1 - 11	-	-

The above pages are in addition to those sent you February 1 for R-6 Supplemental List No. 4.

W. O.   E. W. [illegible]

Portland, Oregon

February 1, 1940

R-6 Supplemental List No. 4

SUPPLEMENTS TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New Pages	Revised Pages	Superseded Pages
C13.3	Service Data Sheet	-	-
	19 - 47	-	-

E. W. Loveridge

Portland, Oregon

January 10, 1940

Supplemental List No. 3

SUPPLEMENTS TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New Pages	Revised Pages	Superseded Pages
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C12.403	Dummy Sheet		
C13.2	14 - 15		
C13.2		1	1
C13.8	Service Data Sheet		
C13.8		Service Data Sheet	Service Data Sheet
C13.8	34 - 69		

Forest Service
R-6

O
RADIO
General

Portland, Oregon

January 10, 1940

Corrections to be made with pen
on Supplemental List No. 2, Radio Handbook

Sec. A4.13, p. 8a, Line 5

Insert "Type K Radiophone" instead of "Type I Radiophone".

Sec. C13.9, Type K Model A

Orange cover sheet, numbers listed on "Model A" line should be "I-21" and "I-39" instead of "1-21" and "1-39". Please insert "40" in first space of Model AA line.

Item 2.11, paragraph (8), page 10, line 6, insert "0-10 ma" instead of "0.10 ma".

Page 22, Item 14, insert "RS-5" instead of MIF-5

Page 23, Item 3, insert "SH-392" instead of "292".

Portland, Oregon

January 4, 1940

Supplemental List No.2

SUPPLEMENTS TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New Pages	Revised Pages	Superseded Pages
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C13.8	Service Data Sheet		
C13.9	Service Data Sheet		
	1 - 25		
		Plate V	Plate V

C. W. Loveridge
W.O.

Portland, Oregon

December 7, 1939

Supplemental List No. 1

SUPPLEMENTS TO U. S. FOREST SERVICE RADIO HANDBOOK

Forest Officer:

The following supplemental pages for the Forest Service Radio Handbook are transmitted herewith for insertion in your copy:

Section	New Pages	Revised Pages	Superseded Pages
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UNITED STATES DEPARTMENT OF AGRICULTURE

2 U.S. FOREST SERVICE, (2a on pf)

F. A. SILCOX, CHIEF

3 RADIO

HANDBOOK //

Prepared By

Division of Operation // O sub

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C13.12	Type SX	
C13.13	Type SXA	
	ADDRESSES OF MANUFACTURERS OF COMPONENTS OF U.S.F.S. RADIOPHONES	I - IV

PART A

PART A

Sec. Al.O INTRODUCTION

The Forest Service has long recognized the need for communication facilities other than those furnished by wire telephone networks. Principally, the need was for communication with mobile units engaged in forest protection work. As early as 1913, radio--wireless as it was then called--was suggested. Also, extensive attempts were made to use the heliograph, but with indifferent success. Later, sporadic trials were made of radio in New Mexico, Montana, Oregon, and elsewhere. This was at a time when radio was far from its present state of development and the experiments were abandoned for lack of adequate equipment.

In 1927, D. L. Beatty, a forest officer whose hobby was radio, demonstrated a small radio telegraph transmitter-receiver to a group of Forest Service officials. Results were so encouraging that Mr. Beatty was urged to devote his entire time to the radio experiment, at least until it was definitely determined whether or not radio equipment, in the current state of the art, could be used advantageously in forest protection work.

It was decided to employ commercial portable radio transmitting-receiving apparatus to find out something about the absorbing effect of green timber on radio signals, and to discover to what extent radio "shadows" thrown by the hills and mountains would interfere with or disrupt communication. To the surprise and consternation of the sponsors of the project, suitable equipment could not be found on the market. Finally, a contract was entered into with a well-known manufacturer of radio apparatus to build two portable outfits. When the sets were received it was discovered that the manufacturer's idea and the Forest Service idea were not the same. They were portable so far as a truck was concerned but one complete outfit could not be packed on a single pack animal. After some modification the sets were finally made to work and considerable time was spent making transmission tests on various western National Forests. Signal measurements were made on radio transmitters set up in brush areas, and under dense mature forest canopies, as well as in deep canyons and on high mountains. Different frequencies were tried both for day and night communication, and varying amounts of power were used.

Early in the history of the project it became apparent that satisfactory results might best be obtained by placing foresters, who also had technical knowledge of radio, in charge of the work. The project was not one of research, but of adapting existing equipment to the very specialized and exacting requirements of forest protection. Obviously, the men who, by years of training and experience, had detailed knowledge of the Forest Service organization and the many different conditions of topography and fire hazards, were best equipped to determine the kind

of tool needed. Cost was of course a factor. In fact, the project was set up as an experiment to determine if radio equipment could be made light enough, strong enough, inexpensive enough, and reliable enough over given distances in the forests, to meet the specific needs of the Forest Service organization. So in January, 1930, Forest Officer Beatty began work on the model of a portable Forest Service radio transmitter-receiver. Later, nine duplicates of this model were built and used throughout 1930 and 1931 in field tests, principally to determine best construction practices and the most desirable form the sets should take.

The 1930 radio set weighed seventy-nine pounds and was put up in four packages. It was a good set electrically and mechanically, and the transmitting range was ample, but it had several shortcomings for forest communication. It transmitted code only; the transmitter was not crystal controlled and had a tendency to drift off the assigned frequency; the set was too heavy and too bulky and the antenna was difficult to install.

After two seasons with nine of these more or less portable code radio sets, it was felt enough data had been accumulated to warrant going ahead with the design of radio equipment for general forest use.

Two new types of sets were designed, namely, the Type SP Radiophone and the Type P Radio. The Type SP Radiophone, in two packages, weighed, complete, about fifty pounds, and transmitted and received both voice and code. The Type P Radio weighed, complete, ten to twelve pounds, received both voice and code, but transmitted code only. About 150 of these two types were put into service for general field tests. Many of them are still in service though they are considered obsolete.

Sec. A2.0 ORGANIZATION

Radio is an all-Service project which is headed up in the Division of Operation, Chief's Office. The radio laboratory is located in Portland, Oregon, and is under the administrative supervision of the Regional Forester. The radio unit is charged with all Forest Service radio development work and equipment procurement.

Forest Service relations with other bureaus and agencies are outlined in the following quotation from Mr. Loveridge's circular letter of June 2, 1936:

> "There are two closely related radio channel authorizing agencies, (a) the Interdepartment Radio Advisory Committee (IRAC), which allocates channels within the bands of frequencies set aside for government use by Executive Order; and (b) the Federal Communications Commission (FCC), which administers all non-federal government radio communication.

R-6 INSERT SHEET - RADIO HANDBOOK
(To be inserted following Part A)

SEC. A2.0 ORGANIZATION

Ultra High Frequency Allocations: The ultra high frequency allocations to various groups of National Forests in Region 6 have been revised to provide for new technical developments and improved interforest communication. These revised allocations supersede those previously issued. They are effective immediately, and are as follows:

Group 1 - Mt. Baker, Mt. Hood, Umpqua, Whitman
Primary frequency 36,620 KC (Black)
Relay frequency 38,820 KC

Group 2 - Chelan, Columbia, Siskiyou, Deschutes
Primary frequency 36,940 KC (Blue)
Relay frequency 38,380 KC

Group 3 - Snoqualmie, Ochoco, Wallowa, Rogue River
Primary frequency 36,420 KC (Green)
Relay frequency 38,620 KC

Group 4 - Wenatchee, Siuslaw, Fremont, Umatilla
Primary frequency 32,780 KC (Yellow)
Relay frequency 34,420 KC

Group 5 - Colville, Malheur, Olympic, Willamette
Primary frequency 32,300 KC (Brown)
Relay frequency 34,660 KC

Group 6 - Fire activities, all areas R-6
Primary frequency 34,260 KC (Red)
Relay frequency 36,780 KC

The following is an explanation of the allocation plan. The grouping of forests is based on topographical separation, permitting common utilization of frequencies allocated to the group:

1. Primary frequency - all regular ultra high frequency equipment on a forest will use the primary frequency allocated for that forest as its principal transmitting frequency.

2. Relay frequency - this frequency is allocated as the transmitting frequency for automatic relay equipment used in conjunction with the primary frequency. In a few cases it may be desirable to operate some other special equipment on this frequency.

3. Primary fire frequency - allocated for emergency fire activities. May be used anywhere in Region Six (See other special uses listed under 6.

4. Fire relay frequency - for special equipment in connection with large fires and as a supplementary frequency for fire cache equipment. Not to be used on forest equipment.

5. Identification color. Since frequencies in kilocycles are useful only to the technician and usually confuse the average user of the equipment, an identification color has been assigned to each of the primary frequencies. Wherever practical these colors will be used rather than frequency in KC to mark the frequency changing switches, dials, antennas and other such devices.

6. Other uses for primary fire frequency. Giving due priority to fire traffic, full use should be made of this frequency for the following purposes:

a. As a supplementary frequency for use during periods of traffic overload on the primary frequency.

b. As a common channel for internetwork, interforest communication, and as a second frequency for mobile equipment serving more than one network area.

c. As a guard channel to intercept unscheduled calls from adjacent areas or from special equipment temporarily used in the area. Where there are several stations in a net, one or more should keep standby on this frequency to intercept such calls.

7. Modern Equipment - all of the equipment being supplied at the present time is of the fixed frequency type utilizing either pretuned circuits or crystal control. With the exception of the type T model D, which is single frequency, all sets have either two or three fixed frequencies. The single frequency sets will be supplied to operate on the Primary channel. The two frequency sets will use the primary and the fire frequency. The three frequency sets can in addition have a frequency the same as allocated to an adjacent forest where such communication is essential and provided there is no interference possibilities with other networks or regions. The use of other group allocations must be approved through request to the Regional Forester.

8. Older equipment - the type S and SV sets are not fixed tune to any specific frequency, but can be tuned by the operator to any frequency between 31,000 and 39,000 KC. They must be kept adjusted to the correct frequency. This can easily be done by using one fixed frequency radiophone in each network and adjusting the S or SV set to correspond. (See procedure in Radio Operator's Notebook).

9. Antennas - the antennas supplied with the set will be adjusted for best efficiency when used on the primary frequency. Where antennas are capable of being adjusted for any group frequency the adjustments will ordinarily be marked with the group color.

"The Forest Service deals with the IRAC, which is made up of representatives of the several governmental departments, and not with the FCC. The Department of Agriculture is represented on the IRAC by E. W. Loveridge, who therefore represents not only the Forest Service but also all other bureaus in the Department.

"All Forest Service radio matters which involve other bureaus or departments or which ultimately must be referred to the IRAC or FCC, should be taken up with the local Regional Forester, who, in turn, will take them up with the Chief, Forest Service, if necessary.

"Questions of purely technical nature should be referred directly to the Regional Forester, Portland, Oregon, by the Regional Foresters.

"In no case should letters be addressed directly to the Federal Communications Commission."

Sec. A3.0 SERVICE POLICIES

Service policies with respect to radio will be found in the Forest Service Manual as follows:

Development	– GA-17	page 4
Procurement	– GA-H2-3	page 5
Use	– GA-17	page 3

Sec. A4.0 DESCRIPTION OF FOREST SERVICE RADIO EQUIPMENT

Following is a general description of the short-wave radio equipment developed by the Forest Service for use on the National Forests. Photographs and descriptive material on Forest Service Radiophones will also be found in Sec. C13.0 of this Handbook and in the Radio Equipment Bulletin which is issued as often as changes in the equipment make necessary--usually annually. The weight data are for complete outfits ready to put in operation and include batteries. The high-frequency equipment is usually built to operate on any frequency between 2500 and 3500 kc and with slight modification can be built to operate in other parts of the radio spectrum between 2000 and 20,000 kc. The Forest Service usually operates in the vicinity of 3000 kc. The ultra-high frequency may be built to operate on any frequency between 30 and 40 Mc.

Sec. A4.1 Type P Radio Unit (Discontinued)

Transmits code (cw) only, but receives both voice and code. Its rated working range is 20 miles. This set was primarily designed for smokechaser use in extremely rugged country, where the

last word in portability is essential. The complete unit weighs only about 10 pounds but because it does not transmit voice has only a limited use.

Sec. A4.2 Type PF Radiophone (Discontinued)

The Type PF Radiophone transmits and receives both voice and code. It weighs about 15 pounds and has a rated working range of about 10 miles on voice and 20 miles when code is used. The PF set was designed primarily for use by smokechasers and the like where reasonably compact and portable voice communication is required. Replaced by Type SPF.

PF Kitbox (Discontinued)

The PF Kitbox is a small chest containing heavier duty batteries than are regularly furnished with the PF Radiophone and a half-wave antenna for semi-permanent installation. A compartment is also provided to house the PF Radiophone. The kitbox, batteries and antenna, exclusive of the PF Radiophone weighs about 35 pounds. Replaced by SPF Kitbox.

Sec. A4.3 Type SPF Radiophone

The transmitter unit when operated with kitbox batteries has a power output of about $2\frac{1}{4}$ watts, and when operated with portable kit bag batteries, $1\frac{1}{4}$ watts. The receiver section is a 5-tube super-heterodyne with a tuning range of 2900 to 3500 kc. The Type SPF, complete with carrying bag, portable antenna, and portable batteries, weighs about 21 pounds; with both "kitbox" and "portable" batteries the weight is approximately 60 pounds. It is not recommended that "portable" batteries be used, except in emergency, because of the relatively heavy battery drain and high cost of portable batteries. With "kitbox" or heavy-duty batteries, the SPF unit is suitable for standby operation as it has a built-in loudspeaker. The SPF set was designed primarily for use by smokechasers where reasonably compact and portable voice communication is required.

Type SPF Kitbox

The SPF Kitbox, together with the SPF Radiophone, is designed primarily to serve secondary lookouts, lookout-firemen, small construction or maintenance crews. In such lookout use the half-wave antenna is permanently installed at the lookout and the SPF Radiophone plugged into the batteries contained in the kitbox. Then, should a lookout need to take his radio set to a fire, it is only necessary to unplug the SPF battery cable, drop the set in the SPF Radiophone bag, which already contains batteries and a short antenna, and he has a complete 21-pound voice set ready to go. Another illustration of the use of

this equipment is the case of a small road camp that has an SPF set as the only means of communication. In camp they use the permanently installed half-wave antenna and kitbox battery, but during a bad fire weather period when working some distance from camp they carry the 21-pound SPF Radiophone outfit out on the job each morning and set it up to keep contact with the fire detection organization during the day and bring the set into camp each evening after work, where it is again hooked up for the evening and early morning schedule.

Sec. A4.4 Type M Radiophone

The Type M Radiophone unit is a 110-120 volt A-c operated transmitter-receiver having a power output of approximately 20 watts and employing a communication type receiver. Provision is made to transmit both voice and code.

There have been a number of models of the Type M Radiophone which have varied considerably in weight, shape, and size. The weight has ranged from 125 to 200 pounds and henceforth will probably be less than 100 pounds.

The M Radiophone has been especially designed for communication with the field from Supervisors' headquarters and central equipment depots, and for use as a central communication station on large project fires.

M sets may be expected to cause interference over a radius of several hundred miles and should never be used except where lower powered sets will not furnish satisfactory communication. Where M sets are used they should be adjusted to emit the minimum power that will give satisfactory service.

Sec. A4.5 Portable Generators

Two portable generator units are available commercially to supply current for the Type M where there is no commercial alternating current. Each consists of a self-excited, self-regulated a-c generator driven by a Briggs and Stratton gas engine which will supply current to operate the Type M Radiophone and any ordinary a-c receiver of the short-wave or all-wave type. The 500-watt unit weighs about 90 pounds and the 700-watt unit weighs about 105 pounds. The 700-watt unit is recommended because of greater capacity and dependability.

Sec. A4.6 Type I Radiophone

The Type I Radiophone is a condensed and simplified unit in-
(*) tended for semi-portable operation on 6-volt storage battery only, and transmits either voice or cw telegraphy. The power output of the Type I transmitter is intermediate between that of the Types SPF and M. Normal output power is approximately $9\frac{1}{2}$ watts.

(*) The Type I is supplied as a single unit incorporating transmitter, receiver, and power supply, in one cabinet. A heavy-duty automobile storage battery is a satisfactory power source.

The Type I is intended as a substitute for the Type M where commercial power is not available and where, because of "stand-by" requirements, or for other reasons, it is not desirable to use a gas-driven portable generator.

The radiophone formerly known as the Type I Model B (mobile) is now designated as the Type K. See Sec. A4.13.

Sec. A4.7 Ultra-High Frequency Radiophones

Ultra-high frequencies (UHF) have the limitation of being good only over optical, or nearly optical ranges. For example, usually it is not possible to communicate between two points when the optical path between the antennas at the respective stations is obstructed by a hill or mountain. But where it is possible to use UHF equipment it offers many advantages over the ordinary short-wave radio. There is practically no fading nor static; the equipment can be made quite light and compact; the antenna is short, being of the order of 15 feet; receiver battery drain is small enough that "standby" operation of battery receivers is possible.

UHF lends itself admirably to linking up emergency lookouts with the regular lookout system. It has also been used successfully for communication nets on large project fires.

Two-way communication with moving vehicles is also possible.

UHF operation is still quite new. Almost daily new tubes, parts, and technique are being developed. In order to keep step with this progress and take advantage of new developments in circuits and parts, the Forest Service has in the past been making sweeping revisions in its ultra-high frequency equipment at relatively frequent intervals. We have now reached a stage of development, however, when it is believed future changes will not be so radical. Rather they will be in the nature of gradual improvements and refinements.

Sec. A4.8 Type T Radiophone Transmitter-Receiver (UHF)

(a) Models CA, CB, CC (Serial Nos. 139 to 309, incl.) (Discontinued)

The Type T Radiophone transmits and receives voice only. The transmitter is a stabilized oscillator amplifier type with power output of approximately 2 watts. It weighs from 50 to 100 pounds, depending on the type of batteries used. The rated working range is about 100 miles over optical paths. The receiver is of the super-regenerative type, is designed for standby operation, and has a built-in loudspeaker. Numerous battery combinations for the unit are available depending on the type of service. With this set it is possible to talk and receive simultaneously when working with another Type T or U Radiophone. However, provision for duplex operation adds considerably to the cost and complexity of the apparatus, and past experience indicates that duplex has only a very limited use in the Forest Service. Therefore, future models of the T set will be of the push-to-talk type as in the Type M Radiophone and not duplex.

(b) Model D

The fact that the Type T Radiophone, as supplied in preceding models, has had numerous technical and operating faults has been appreciated. The Type T, Model D, is an entirely new device designed to overcome the shortcomings of previous Type T Radiophones.

The Model D is crystal controlled and has a power output of 2 watts. Push-to-talk operation is provided, as in the Type M. The receiver is of the superheterodyne type, with a sensitivity of about 5 microvolts, and is sufficiently broad to receive modulated oscillators such as the Type S Radiophone. A silent standby call bell is provided. This device operates a buzzer when a signal is received, thereby avoiding a noisy loudspeaker in constant operation when unscheduled calls are expected. Battery drain on the Model D is extremely low.

Before ordering or attempting to use the Type T, Model D, it is essential that the functional differences between this and the preceding models be understood. Without this information it is entirely possible

that the new device may be applied in such a manner that it will not provide the desired communication. When applied to a planned communication system with full consideration given to its operating limitations, the Model D should prove to be an exceptionally superior radiophone in most applications where preceding models of Type T have been used.

For information concerning functional differences between Model D and previous models, refer to Sec. C13.7, Type T, Model D, 0.0 General Description.

Sec. A4.9 Type S Radiophone Transceiver (UHF) (Discontinued)

The Type S Radiophone transceiver transmits and receives voice only and has a power output of about one-tenth watt. It weighs about 8 pounds. The rated working range is about 50 miles over optical paths. Working with antenna close to the ground over level terrain the range may be reduced to no more than 1 or 2 miles. This set will not work duplex as the same circuit is used for both transmitting and receiving. It has been used by smokechasers and by scouts and fire chiefs on large fires. Its principal features are its portability and the quickness with which it may be put in operation. Type S sets have occasionally been used for two-way communication with moving vehicles.

Sec. A4.10 Type A Radiophone (UHF)

Type A Radiophone has been especially designed to meet Forest Service requirements in emergency airplane use and has a power output of about 3.5 watts. The unit is not designed to work more than about 10 miles. Its principal feature is the quickness with which it may be installed in planes which have no provisions for radio. It can be installed in practically any type of plane without special tools or mechanical skill. The Type A will communicate plane-to-ground over limited distances even in unshielded planes. It weighs about 25 pounds exclusive of power supply and operates from a 6-volt storage battery or from the storage batteries regularly incorporated in most airplanes.

Sec. A4.11 Type U Radiophone

This is an a-c operated UHF radiophone transmitter-receiver especially intended for central station use such as at central fire dispatcher offices. The unit is 19 inches wide, 4 feet 9 inches high and 12 inches deep. The approximate shipping weight is 300 pounds. It has an output of about 20 watts. No antenna is furnished with the unit as the antenna for each installation should be built at the point where the set is to be used to conform to the physical limitations of the location. Wherever the outlying stations to be communicated with are all within one general direction from the U set (an arc of 180° or less), directional or "beam" antennas should be used.

The outstanding feature of this unit is its simplicity of operation. When a call is received on the standby loudspeaker it is only necessary to pick up the handset to answer. Lifting the handset automatically turns on the transmitter.

Sec. A4.12 Type SV Radiophone Transmitter-Receiver (UHF) (Discontinued)

The Type SV Radiophone is a larger and more powerful edition of the Type S Radiophone. Where the additional weight, bulk, and cost can be endured, it offers several marked advantages over the Type S. It transmits and receives voice only and is intermediate in power between the Types S and T. The estimated working range may vary from 80 miles between mountain lookouts to as little as 2 or 3 miles under certain level-ground conditions. The Type SV has independent transmitting and receiving sections mounted on the same chassis. This completely eliminates the frequency shifting between transmit and receive which is encountered in the Type S. A loudspeaker only is provided on the receiver. The same antenna is used for both transmitting and receiving. A special method of coupling permits a wide variation in the types of antennas employed.

For medium duty or intermittent service all batteries are contained in the set cabinet. Heavy-duty batteries for continuous operation may be attached externally by means of a special cable which, if desired, must be ordered as an accessory item.

Weight, complete with medium-duty batteries, is 18½ pounds.

Sec. A4.13 Type K Radiophone (Formerly known as Type I, Model B, Mobile)

The Type K Radiophone operates in the high-frequency range (3000 kc) and is intended for mobile use on Forest Service cars and trucks. Voice communication only is provided. The radiophone operates from the automobile battery and a normal output power of 9½ watts is provided.

The Type K is supplied in individual units receiver, transmitter, and power supply, for mobile installation in cars or trucks, and in such instances the several units are distributed under the dash or wherever space is available. The receiver is similar in appearance to a conventional automobile radio receiver. It is equipped with a very satisfactory system of push-button tuning which may be mounted near the steering column of the vehicle.

A special rod-type antenna, together with a special tuning box, is supplied for fender or bumper mounting.

The mobile unit transmits and receives voice only and has a normal transmitting range of about 20 miles. The receiving range is, of course, greater and is comparable to that of any good communication type receiver under similar conditions.

When ordering the Type K Radiophone, give type, make, and year of vehicle so that a suitable tuning head may be supplied.

Sec. A4.14 Type KU Radiophone (UHF)

The Type KU Radiophone (UHF) is intended for use on Forest Service cars and trucks, and provides only voice communication. The working range over optical paths is estimated at 100 miles. However, when communication is over level ground to a station with a low antenna, this may be reduced to as little as 10 miles. The radiophone operates from the automobile battery and has a normal power output of 9 watts.

The Type KU Radiophone consists of a Type KU-R receiver, a Type KU-T transmitter, and a special rod antenna about 7 feet long. To facilitate installation in vehicles, the transmitter is supplied in two units - transmitter and transmitter power supply. In view of the likelihood that temporary installations of receiver only may be made in some cars, the mechanical design of the receiver adapts it to easy and rapid installation.

Sec. A4.15 Type SX Radiophone (UHF)

The Type SX is a stabilized portable UHF radiophone having extreme flexibility in application. It serves scouts, smokechasers, and others requiring extreme portability. The addition of the Type SXA attachment, which incorporates a loudspeaker, adapts the unit to semi-portable service in lookouts, ranger stations, and wherever standby operation is needed. The Type SX in the portable form supersedes the Type S, and with the attachment supersedes the Type SV. The attachment is readily connected to or removed from the radiophone, no technical skill, additional wiring, or mechanical change being necessary.

The Type SX transmits and receives voice only. The portable unit weighs 10 pounds, and has a rated working range of about 50 miles over optical paths. However, with low antennas and over level ground this may be reduced to 3 or 4 miles. A panel switch permits selection of any of 3 transmitting frequencies, any or all of which may be crystal-controlled. The receiver is substantially noninterfering.

Sec. A5.0 PLANNING AND APPLICATION OF RADIO FACILITIES

It is axiomatic that communication, like other forestry facilities, should only be used on a plan-wise basis.

After it has been determined that an actual need for communication exists, the next step is to decide whether this communication shall be through the medium of wire telephone or radio.

In general the telephone will furnish better communication than radio, though there are many exceptions to this generalization. A rough comparison of telephone and radio follows:

Telephone	Radio
Bell ringing will rouse the attendant at night, making for 24-hour service.	At present receiver with loudspeaker must be operated to attract attention. Does not exclude unwanted signals and noises. (Exception: New Type T.)
Some communication privacy.	No communication privacy.
Can be tied in to the commercial long-distance telephone network.	Ordinarily cannot be tied in to commercial lines. In certain special cases can be connected to Government telephone lines.
Requires no operator attention when not actually in use.	
Not satisfactory for mobile communication.	Will furnish communication to mobile units.
Cannot be moved. (Exception: Portable telephone.)	Can be moved readily.
	First cost and maintenance cost less than telephone except for very short lines.

Usually is disconnected during thunderstorms, hence inoperative.	Certain types can be operated through thunderstorms.
	Can be used where snow slides, rock slides, and topographic features prevent construction of maintenance of telephone lines.

If, after a careful analysis of the problem, it is decided to use radio, the next step is to select the proper type of radio equipment for the job. This selection can best be made by the radio technician. The administrative officer should define the communication problem and the communication engineer should recommend the type or types of radio apparatus best suited to furnish the required communication. So many factors are involved that it is unwise and might be misleading to set up any general guiding rules or principles for use in making the selection. However, a few typical examples of radio application may be helpful.

Ultra-high frequency radiophones such as the Type T are especially adapted to inter-lookout radio communication. The sets are operated "standby," that is, the receiver is operated continuously so long as the lookout is on duty. Thus calls may be made at any time instead of at pre-arranged, scheduled intervals. The antennas are very short--only about 15 feet long and directive antennas are readily installed where it is desired to increase the signal level in any one general direction. A type of antenna may be used that is grounded at all times, which is a desirable feature in a lightning country. The ultra-high frequencies are almost entirely free from static thus permitting operation during thunderstorms.

On some Forests this same Type T Ultra-High Frequency Radiophone is also used as a ground station for communication with reconnaissance planes and patrol cars.

Where communication is required over other than line-of-sight distances and where the utmost in portability is not necessary, the general-purpose Type SPF Radiophones are used. They are used on lookouts for inter-lookout and headquarters communication and to maintain contact with mobile units such as smokechasers, road and trail crews, CCC camps, etc.

SPF Radiophones, with or without kitboxes, are the backbone of the fire radio communication system both in presuppression and suppression work.

Type M Radiophones have considerably more power than other types of Forest Service radio equipment, hence are used for communication over distances beyond the range of the lower powered units. Ordinarily their

use is limited to points where commercial a-c electricity is available, such as at Supervisors' headquarters, equipment depots, etc.

Sec. A6.0 COMMUNICATION NETS ON PROJECT FIRES

Communication on large project fires represents a special and distinct problem largely because it requires an intense concentration of stations within a relatively small area, thereby engendering the possibility of heavy interference. The extent to which radio is used is, of course, dependent upon a number of factors, such as number of men employed, fire-fighting methods, possible duration of fire, fire administration system, available wire facilities, transportation and source of supply.

Communication demands are greatest on large fires in Regions 1, 5, and 6. Many of the largest fires in these Regions occur where wire facilities are inadequate or non-existent. Some of the specific communication needs are:

Base camp contact with sector camps and packer and spike camps.

Base camp contact with supervisor's headquarters.

Base camp contact with Regional Office and equipment depot.

Inter-sector camp contact.

Sector camp contact with fire scouts, reconnaissance and transport planes, sector bosses on the line, and fire lookouts.

Fireline communication between crews and sectors on the line.

Inter-lookout communication.

Communication with fire weather trucks. The fire weather trucks in the western regions have been allocated a special frequency of 3397.5 kc. Thus the fire weather unit can collect the weather messages from the observer stations and issue weather forecast broadcasts without interrupting the flow of traffic on the "fire" radio net.

Sec. A6.1 Equipment and Channels

The types of equipment used will depend on local conditions and available apparatus. The base camp ordinarily will use one or more M Radiophones, extra communication type standby receivers, and an ultra-high frequency radiophone of the T or U type. When a number of stations are involved and the traffic load is heavy, it will often be found necessary to use several radio channels both in the "fire" and the UHF bands. Multi-channel operation requires duplication of equipment but is well worth while in increasing the traffic handling capacity of the network.

Sec. A6.2 Personnel

On some fires, where there are considerable communication needs, all such facilities have been placed under the direction of a communication chief.

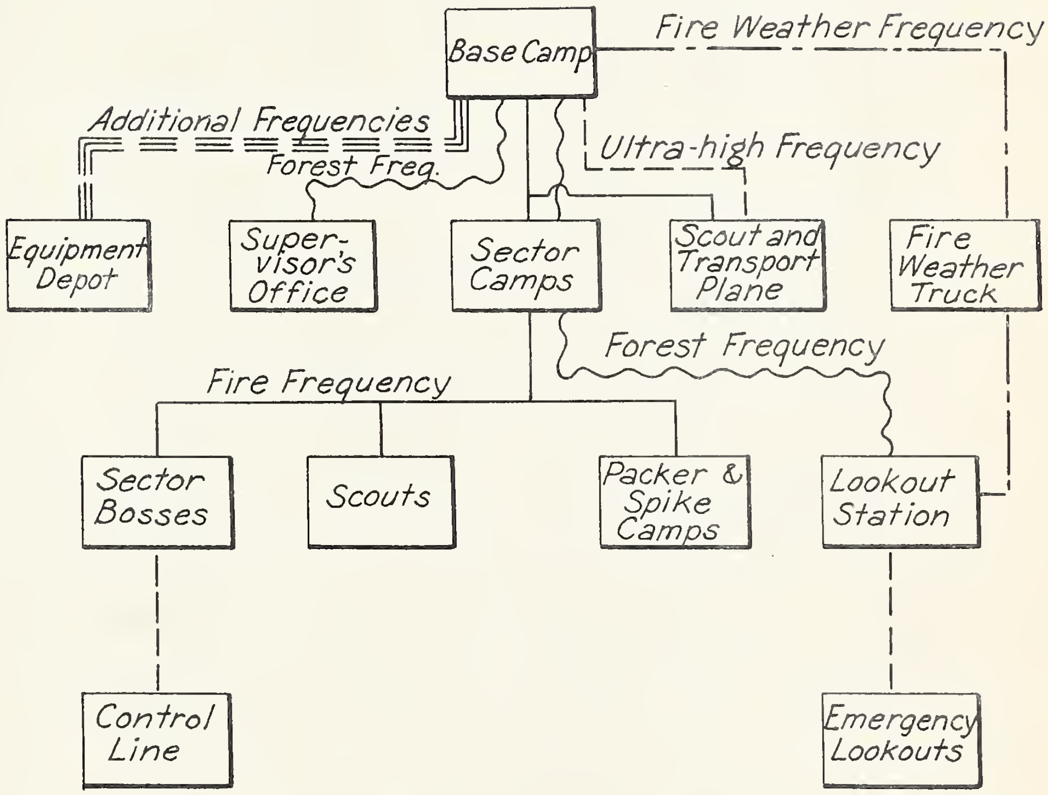
Where a communication chief is employed it is his responsibility to provide communication wherever needed on the fire; to insure that an adequate supply of radio apparatus is available at all times; and to insure that at all times men who have been instructed in the use of the radio are available to send out with the equipment.

Several Regions have organized emergency operator squads with good success. Usually the squad is composed of young operators who are fairly proficient in code and who are employed on a per diem basis. In at least one Region the squad has developed into a highly trained, closely knit organization. The members are carefully selected, and are trained through field practice with Forest Service radio apparatus and through a series of lectures delivered by Regional Office personnel at the semi-monthly meetings.

Emergency squad operators are, of course, used wherever needed but the general tendency is to use them at stations where the traffic load is heaviest.

Advantage should be taken of every opportunity to train CCC enrollees for radio work. One convenient method is to use promising enrollees as messengers and assistant operators at the base camp and sector camps.

Suggested Radio Net on "Conflagration" Fires:



PART B

PART B

Sec. B7.0 OPERATORS AND OPERATING PRACTICE

The following section on Operators and Operating Practice is generally applicable but is addressed primarily to operators on fires.

The radio operator is an important member of the fire organization. Very often human lives are dependent on the uninterrupted functioning of the communication system. Obviously the operator should maintain his equipment and himself at top-notch efficiency at all times.

His antenna installation will be the most favorable local conditions will permit.

His radio set will be conveniently located, yet protected from the weather.

He will requisition replacement batteries and other materials often enough to insure his station always being operative.

He will report equipment trouble or failure at the earliest possible moment.

He will guard his health and keep as physically fit as the job permits so that he will not fail in emergencies.

By example, he will show that he can "take it" and come up smiling.

The two outstanding attributes of a good operator are Accuracy and Speed, but most of all Accuracy. Remember a good operator never guesses.

There is no excuse for errors and omissions in handling messages, yet sometimes they do occur. The most common sources are:

1. Failure to read sender's handwriting correctly.

   Don't guess. Wherever possible read back the message to the sender to make sure you have it correct.

2. Errors or omission in transmitting the message.

   Mostly due to voice operators not speaking distinctly and cw operators not sending clean-cut characters.

3. Errors and omission by receiving operator in transcribing the message.

Don't guess. Check all doubtful words with the sending operator. Never receipt (OK) for a message until definitely sure that the message is correct in every detail. It is not always possible to obtain from the transmitting operator immediate confirmation on a doubtful message. Occasionally extreme urgency may even make it advisable to give the addressee the incomplete text for his information. But in such instances it should be made very clear to him that he is merely being given some advance information on an unconfirmed and unreceipted message.

Speed does not necessarily mean haste, nor does it necessarily mean rapid speech or fast sending.

The speedy operators are the operators who move a message from the sender to the addressee with the least delay and without error. Probably the greatest conducives to speed are the use of set forms of procedure in the various operations of handling traffic. There should be fixed and definite forms for contacting a station, clearing a station, transmitting a message, requesting "fills" in a message, and receipting for a message. Well designed forms of procedure reduce errors and needless repetitions, and increase the traffic handling capacity of a circuit.

Following are recommended forms of radio operating procedure:

Sec. B7.1 Calling

The purpose of a call is to attract the attention of the station called and to identify the station calling. The procedure should be such as to reduce time on the air to a minimum. If signals are good, if there is but little interference, and if the operators are skilled, it may only be necessary to transmit the call of the desired station and your own call once. Under less favorable conditions it may be necessary to repeat the call several times. After contact has been established, it is usually unnecessary to transmit call letters every time one switches from receive to transmit. Details of calling procedure will be found in the instruction books which are furnished with each radiophone.

Sec. B7.2 Meeting a Schedule

In calling a station on schedule, if you have a message for him say "Traffic" immediately after the call letters and just before you say "Go ahead." If you have no traffic for him, follow the call letters by the statement "Nothing for you. See you next schedule" or "See you at__________(a.m. or p.m.)."

If the other station has traffic, he will transmit it; then stand by for your OK and your traffic. If you have traffic but he has none, he will say "Nothing here, go ahead your traffic." If neither of you has traffic, the answering station replies to your call thus: "OK. Nothing here."

After completing a contact, make it a practice to tune carefully over the entire Forest Service band to pick up any unscheduled calls. This is especially important since the advent of mobile radio in the Forest Service. Someone on some other frequency may have an urgent message for you.

Sec. B7.3 Messages

A message is made up of four parts, namely, Preamble, Address, Text, Signature.

The Preamble comprises data necessary to the operator in the business of handling message traffic accurately and expeditiously. It may include the Number (serial number of the message), operator's Sine (usually his initials), station Call letters, Check (word count), Date, Time, and Place of Origin. In Forest Service practice, operators' sines are seldom transmitted. Not many Forests use checks and the date of the message is never transmitted unless the message was filed on a date previous to the date of transmittal.

The Address includes the name or title of the addressee and the delivery point of the message. Messages are incomplete if addressed merely to a place and should not be accepted. For example, a message addressed "Clear Creek Fire Camp" is incomplete. Obviously such a message might be intended for anyone from the fire chief to the waterboy. Such addresses as "Jones, Clear Creek Fire Camp," "Jones, Fire Chief, Clear Creek Fire Camp," "Timekeeper, Clear Creek Fire Camp," "Official in Charge, Clear Creek Fire Camp," or "Forest Officer, Clear Creek Fire Camp" (Note: Messages addressed to "Forest Officer" will be delivered to the ranking Forest Officer or to the Forest Officer in charge) are complete addresses and show to what specific individual the message should be delivered.

The Text is the body of the message and may be in code or plain language.

The Signature should be the name or title or both of the person responsible for the origin of the message. The same requirements of completeness apply to signatures as to addresses.

Never take it upon yourself to explain, amplify, or modify any message you handle, either to the addressee or the addressor.

Sec. B7.4 Message Priorities

When traffic loads are heavy often it is not possible to clear it as rapidly as it is filed. The following priorities should apply in handling traffic unless the operator is specifically instructed otherwise by his official superior:

--Classes of Messages--

1. Messages concerning medical aid, sickness, injuries, death.

2. Messages concerning fire administration, such as movements of fire-fighting forces, scout reports, etc.

3. Messages concerning food and equipment, such as grub and tool orders.

4. Messages concerning fiscal matters such as time slips and payroll data.

5. Routine reports.

When it is necessary to clear the air and contact a station as quickly as possible in order to transmit rush emergency traffic, the operator should follow the station call with the word "Emergency" or "Urgent" repeated several times. So transmitted, these words have much the same significance as SOS or QRR. All stations will do whatever is necessary to expedite such traffic.

"Emergency" or "Urgent" calls should not be made unless the necessity clearly warrants it. Obviously if used promiscuously the calls would soon lose their force.

Where it is desirable or necessary to transmit a message as quickly as is reasonably possible, the word "Rush" should be used rather than the "distress" words "Emergency" or "Urgent."

Sec. B7.5 Secrecy of Radio Communications

Except as noted below, it is unlawful to intercept a radio message (which includes official conversations) or to divulge the contents or even the existence of any message by wire or radio to any person except the addressee or his agent. Exceptions are: Messages sent by amateurs, or others, for the benefit of the general public, or relating to ships in distress.

The federal law imposes heavy penalties for violations.

Complete text of the Act as it relates to secrecy of messages follows:

UNAUTHORIZED PUBLICATION OF COMMUNICATIONS

The following is quoted from the Communications Act of 1934:

"Sec. 605 - No person receiving or assisting in receiving, or transmitting, or assisting in transmitting, any interstate or foreign communication by wire or radio shall divulge or publish the existence, contents, substance, purport, effect, or meaning thereof, except through authorized channels of transmission or reception, to any person other than the addressee, his agent, or attorney, or to a person employed or authorized to forward such communication to its destination, or to proper accounting or distributing officers of the various communicating centers over which the communication may be passed, or to the master of a ship under whom he is serving, or in response to a subpena issued by a court of competent jurisdiction, or on demand of other lawful authority; and no person not being authorized by the sendor shall intercept any communication and divulge or publish the existence, contents, substance, purport, effect, or meaning of such intercepted communication to any person; and no person not being entitled thereto shall receive or assist in receiving any interstate or foreign communication by wire or radio and use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto; and no person having received such intercepted communication or having become acquainted with the contents, substance, purport, effect, or meaning of the same or any part thereof, knowing that such information was so obtained, shall divulge or publish the existence, contents, substance, purport, effect, or meaning of the same or any part thereof, or use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto: Provided, That this section shall not apply to the receiving, divulging, publishing, or utilizing the contents of any radio communication broadcast, or transmitted by amateurs or others for the use of the general public, or relating to ships in distress."

GENERAL PENALTY

"Sec. 501 - Any person who willfully and knowingly does or causes or suffers to be done any act, matter, or thing, in this Act prohibited or declared to be unlawful, or who willfully and knowingly omits or fails to do any act, matter, or thing in this Act required to be done, or willfully and knowingly causes or suffers such omission or failure, shall, upon conviction thereof, be punished for such offense, for which no penalty (other than a forfeiture) is provided herein, by a fine of not more than $10,000 or by imprisonment for a term of not more than two years, or both."

Sec. B7.6 How to Transmit a Message

Some practice is necessary to gauge the reading speed to the writing speed of the receiving operator. One method that is of great aid in regulating transmission speed as well as making for greater accuracy is to pronounce and spell each word of the message. Superficially, it may seem to be a slow process but, actually, messages can be read off by this method much faster than the average Forest Service operator can write them down either in longhand or on the typewriter.

There is some variation in the form for transmitting a message, depending on local rules regarding the amount of preamble data to be transmitted. A sample message as a recommended example follows:

(File 0-37) RADIOGRAM
U. S. FOREST SERVICE

Sent: No. 6 To Sta. KBCC Time Sent 1138 Oper. BR Sta. KBAB

Rec'd: No.____ From Sta.____ Time Recd____ Oper.____ Sta.____

Place Red Mt. Date 7/20/38 Time 1120 To Jones At Mt.Shasta

Need 10 more men

Signed Smith

Time Delivered____ Received

By Radio ___ Telephone ___

Messenger ___ In Person ___

____
(Initials)

This would be transmitted thus:

"Number 6 filed 1120 Red Mt. to Jones Mt. Shasta need 10 more men signed Smith. Go ahead."

Sec. B7.7 Initials and Proper Names

Initials and proper names may be transmitted with less chance of error if each letter is named. For example, the name A. B. Cox might be transmitted thus: A-Adam, B-Boston, C-Charles, O-Ocean, X-Xray.

A list of standard code words follows:

A-Adam	J-John	S-Sugar
B-Boston	K-King	T-Tom
C-Charles	L-Lincoln	U-Union
D-Denver	M-Mary	V-Victor
E-Edward	N-Nellie	W-William
F-Frank	O-Ocean	X-Xray
G-George	P-Peter	Y-Young
H-Henry	Q-Queen	Z-Zebra
I-Ida	R-Robert	

Sec. B7.8 Choice of Words

The suggestions contained in this section, while useful to the operator, should be especially helpful to the forest officers who prepare radio messages in improving the clarity of the messages and insuring their correct transmission.

Choice of words in making up a message determines to a large extent whether the receiving operator will copy it correctly the first time or find it necessary to ask for repeats. Unnecessary words which do not affect the message meaning should be avoided.

Choose words and phrases that are distinct and forceful in sound and that convey a definite thought. One word may be mistaken for a number of others that sound like it, whereas another of the same meaning could not be mistaken. The word "want" sounds like "jaunt," "haunt," "can't" and many others; on the other hand, "desire" is a distinct, forceful word and not likely to be miscopied. Comparative lists of "poor" and "preferred" words follow:

Poor	Preferred
Want	Desire
Can't	Unable
Buy	Purchase
Get	Obtain
Send	Forward
Regarding your message	Reradio
Do you want us to send	Advise if desire forward

The operator may choose many preferred words and phrases by repeating them to himself to see how they sound.

When a message is handed the operator for transmitting, he should read it back to the writer to make sure he can read it correctly. At the same time, without offending the writer, he may ask, "May I word it this way? It will transmit more easily." Obviously, the operator may not substitute a "preferred" word for a "poor" word except with the consent of the writer of the message.

Sec. B7.9 Requests for "Fills"

Requests for "fills" in a message should always be made according to the following forms to avoid misunderstandings and needless repetition. For example, suppose the receiving operator has: "Report your total _______ _______ of this date." He requests the fill thus: "Go ahead 'your total' stop 'of this.'" The transmitting operator replies: "Your total strength as of this date."

If the address and some of the first part of the text were missing--say the first word--the receiving operator would ask for a fill thus: "Repeat all before 'your total.'"

If the missing part is at the end of the message, the receiving operator will say "Repeat all after------ (the last two words of the text that he has OK)."

Sec. B7.10 Receipting for a Message

Instances have occurred where, because of interference, haphazard methods of receipting for messages, and promiscuous use of OK's, the transmitting operator thought he had an OK on his message though the receiving operator had not heard the message at all and it became lost. To reduce the possibility of such mischances, messages will be receipted for in the following language: "Your message to ---- received OK at --- (time)." If messages are numbered serially the wording will be: "Your message number ---- received OK at ---- (time)."

Sec. B7.11 Message Files

File copies should be kept of all messages transmitted or received. The message file constitutes a highly important record of official action and great care should be exercised to preserve this record in its entirety. Fire camp operators should turn over the message file intact to their relief. When the station is closed down, the radio operator should turn the file over to the camp boss or to the base camp chief operator unless specifically instructed otherwise.

Sec. B7.12 Radio Logs

It is obviously impossible to maintain complete radio logs at all Forest Service radio stations, especially the portable and mobile

stations. Where possible, however, it is desirable to maintain records of the date, time, and place of radio transmissions and a record of stations worked. The Chief's Office has arranged for the General Printing Office to print a supply of standard Forest Service Log Books and they are available on requisition.

PART C

PART C

Sec. C8.0 FUNDAMENTALS OF RADIO

In view of the vastness of the subject of radio, it is not possible to give even a brief treatment to radio principles here. Numerous good texts and handbooks are available, however. It is urged that the field technician familiarize himself at least with some of these and keep one or more always at hand for consultation and reference.

Sec. C8.1 Practical Fundamentals of Radio

The Radio Amateur's Handbook (New edition issued annually) American Radio Relay League, West Hartford, Conn., $1.00.

While the above handbook is intended primarily for radio amateurs, the wealth of practical application data justifies its possession by anyone actively engaged in radio work. An excellent chapter on elementary theory is included, together with well-written practical information concerning antennas, receivers, transmitter components, oscilloscopes, wave propagation, and related subjects.

Henney, Keith (Editor-in-Chief)
Radio Engineering Handbook, 2nd Edition, 1935, McGraw-Hill Book Co., New York, $5.00.

This is a practical handbook intended for engineers and technicians. Underlying principles are treated for all of the more usually encountered phases of radio and kindred subjects.

Rider, John F.
The Cathode-Ray Tube at Work, 1935, John F. Rider, Publisher, 404-4th Avenue, New York, $2.50.

This is a complete non-technical discussion of the operation and use of cathode-ray oscilloscopes. The text is written in the "popular" style, and is practically non-mathematical. The book is well illustrated with many drawings and photographs of actual oscilloscope patterns. It provides a suitable understanding for the use of this valuable instrument.

C8.2 Theoretical Fundamentals of Radio

Terman, F. E.
Radio Engineering, 2nd Edition, 1937, McGraw-Hill Book Co., New York, $5.50.

This text deals with radio principles in the thoroughgoing manner desired by serious workers. The subject matter is as complete as can be expected in a text embracing so large a scope. Numerous footnote references to published articles direct the reader to more specialized information where needed. Mathematics has been reduced to the minimum necessary for adequate treatment. While the advanced worker may be expected to benefit most from this book, its possession is highly recommended by anyone actively engaged in radio work.

Henney, Keith
Principles of Radio, 3rd Edition, 1938, McGraw-Hill Book Co., New York, $3.50.

This is a more elementary treatment of the fundamentals of radio. The work is well written and practically non-mathematical.

Morecroft, John H.
Principles of Radio Communication, 3rd Edition, 1933, John Wiley & Sons, New York, $7.50.

This text is a long-established and comprehensive treatment of radio principles. However, the treatment is definitely mathematical, and many of the later developments are not included. This book is still highly regarded by persons making a thorough study of radio.

Morecroft, John H.
Elements of Radio Communication, 1929, John Wiley & Sons, New York, $3.00.

This good presentation of fundamental theory is a suitable introduction to more highly technical books. Statements concerning theory are frequently related to the reader's experience by supplementary discussion of pertinent radio equipment. However the apparatus thus mentioned is now largely obsolete.

Everett, W. L.
Communication Engineering, 2nd Edition, 1937, McGraw-Hill Book Co., New York, $5.00.

This is an advanced text containing an excellent treatment of communication circuits. The method is mathematical, and is of most value to advanced radio students.

Sec. C9.0 ANTENNAS, GENERAL

This section is written to provide field technicians with design data for antennas to be used with USFS radio equipment. It is intended that this information will be used for necessary field replacement of standard Forest Service antennas and for construction of special antennas where local needs cannot be met adequately with standard antennas.

Sec. C9.100 Antennas, 3000 Kc

Sec. C9.101 Half-wave Antennas, 3000 Kc

The half-wave antenna with single-wire, off-center feed is standard equipment at semi-permanent locations for Types I, M, and SPF Radiophones. This antenna has maximum radiation in a direction at right-angles to the wire and has minimum radiation in the direction along which the wire points. Intensity of radiation is not highly critical to minor changes in the angle between the wire direction and the direction of the other station.

Although this antenna will provide communication over a limited range when erected to a height of only 6 feet, its dependability and range will be improved greatly by increasing the height, up to 75 feet. A height of 20 feet should be considered a minimum. Where possible the antenna should be erected in the clear of leaves, branches, and other obstructions. In no case should the wire be allowed to touch any such obstructions. The radiating section of the antenna, i.e., the flat top section, must not be folded. It must be stretched out in a straight line. The feeder, i.e., the lead-in wire, should come off the radiating section as nearly at right angles as possible. In installations where the feeder cannot possibly traverse the entire distance to the transmitter at right angles to the flat-top section, a bend in the feeder may be tolerated. However, a length of at least 75 feet adjacent to the antenna should be at right angles to the radiating section. The length of the radiating section must not be altered. The length of the feeder may be changed as necessary to conform with local conditions. The feeder should be kept in the clear as far as possible, and must not be run closer than 3 feet to metallic objects, such as sheet metal roofs.

Table 1 shows dimensions of the half-wave antenna for the different USFS frequency assignments.

Table 1

Frequency	Antenna Length	Feeder Tap Point (Distance from 1 end)
3095 kc	152' 2"	54' 9½"
3155	149 3½	53 9
3195	147 5	53 1
3235	145 7	52 5
3265	144 3	51 11
3295	142 11	51 5½
3345	140 9½	50 8½
3385	139 1½	50 1
3445	136 9	49 2½

The standard antenna supplied with Types I, M, and SPF Radiophones has a radiating section made of #14 AWG enamel wire, while the lead-in section is #16. Insulators are National Type AA-6. Where above materials are not available, other suitable types of wire and insulator may be used. For instance, bare wire or copperweld of approximately the above sizes may be employed, and any clean strong insulator which provides adequate separation between antenna wire and support can be used. The connection between lead-in wire and antenna must be strong mechanically, and must be soldered. The dimensions listed in Table 1 must be adhered to.

Sec. C9.102 End-fed Antennas, 3000 Kc

The end-fed antenna is intended strictly for portable operation where ability to set up quickly is important. The length is so chosen that when used with a Type SPF or PF Radiophone, the loading will be about 15 milliamperes of final plate current. This assumes that the Radiophone has been adjusted to load about 22 miliamperes with its single-wire fed half-wave antenna. The lower loading is used with the end-fed antenna because it and the shorter-lived portable batteries are frequently used together. Proper length for the end-fed antenna depends both upon the frequency and the Radiophone with which it is used. Table 2 shows proper lengths for different frequencies and Radiophones.

Table 2. Lengths of End-fed Antennas

(a) Type SPF, serial numbers 1 to 264, incl.

Frequency Kc.	Length Ft.
3445	105
3385	110
3345	110
3295	110
3265	110
3235	115
3195	115
3155	120
3095	125
2994	125
2952	130
2698	140

(b) Type SPF, serial numbers in excess of 265.
(Models AA and AB)

Frequency Kc.	Length Ft.
3445 to 2952	$102\frac{1}{2}$
2770	$111\frac{1}{4}$

(c) Type PF, serial numbers 111 to 203, incl.

Frequency Kc.	Length Ft.
3445	115
3235	125
3195	130

(d) Type PF, serial numbers 204 to 360, incl.

Frequency Kc.	Length Ft.
3445	115
3265	123
3095	128
2994	130

(e) Type PF, serial numbers 361 to 432.

Frequency Kc.	Length Ft.
3445	105
3385	110
3345	110
3295	110
3265	110
3235	115
3195	115
3155	120
2994	125

The conductor for the end-fed antenna is 7-strand, #16 AWG flexible bare copper wire. One end is fastened to 25 feet of light sash cord, through a National Type AA-5 insulator.

Sec. C9.103 Vertical Quarter-wave Antennas, 3000 Kc

Limited experience at the Radio Laboratory has indicated that a vertical one-quarter wave antenna may transmit a signal which is nearly free of fading over the distance range which USFS Radiophones are rated to operate; i.e., distances up to 20 miles. The superiority of the vertical wire over the half-wave wire appears to be more evident during the daytime than at night. In view of some promising results of preliminary tests, it is expected that the Laboratory will continue field tests of the vertical antenna and will issue a supplement to this section when more conclusive information is available.

A vertical one-quarter wave antenna requires a mast at least 80 feet high, which is obviously impractical for portable use. Nevertheless, at some semi-permanent locations such an antenna may possibly reduce fading as compared to a horizontal half-wave antenna. If a transmission line is used, a special matching network must be designed. If the antenna connects directly to the transmitter, it may be necessary to make internal changes in the transmitter, to enable the transmitter to deliver full rated power to the antenna. This antenna requires a ground connection. In some soils a suitable radio ground may not be provided by the usual metal ground rod, and it may be necessary to build a resonant counterpoise.

If erection of a vertical antenna is contemplated, detailed technical design data should be obtained from the Radio Laboratory. The letter of inquiry should contain information concerning distance and terrain over which it is desired to transmit, nature of signals received with present antenna, height of mast erected or contemplated, distance from transmitter to mast, and type of Radiophone used.

Sec. C9.104 Mobile Antennas, 3000 Kc

For installations where the Type I Radiophone is operated mobile in automobiles and trucks, a fishpole antenna and accessories are provided. A flexible concentric transmission line connects the transmitter with the matching unit at the base of the fishpole.

When adjusted properly, about 15% of the transmitter power will be radiated from the fishpole. With this antenna the Type I Transmitter will provide a normal daytime range of about 20 miles.

Fig. 1 is the schematic diagram of the mobile antenna installation. In the matching section, L-4 is tuned to resonance by capacitor C-17 in parallel with the capacitance of the fishpole to ground. One side of the transmission line is grounded at the matching unit, while the other side taps up 1 or $1\frac{1}{2}$ turns on L-4. Selection of the proper

tap point on L-4 matches the antenna load to the surge impedance of the transmission line. The length of line involved is short compared with a quarter wavelength, so that in case of mismatch the possibility of standing waves on the line is not important. However, an approximate match must be obtained between line and load, so that currents and voltages in the line will be of such magnitudes as not to cause excessive losses, and so that the line will not reflect reactance across C-10 and thereby interfere with proper tuning of transmitter output circuit.

C-17 has a maximum capacitance of 25 mmf. A condenser of more capacitance must not be substituted for C-17, as this would seriously impair the antenna efficiency. L-4 is wound on a $2\frac{1}{4}$" form with #18 enamel wire, 16 turns per inch. For 3385 kc, about 38 turns are required. For a typical left-fender installation on a panel delivery type vehicle, the antenna has a capacitance of about 30 mmf to the body of the car, and has a radiation resistance of possibly $2\frac{1}{2}$ ohms referred to the base.

The matching section is housed in a rugged sheet metal case, which supports the fishpole on a ceramic bowl insulator. A hinged joint is provided between the insulator fitting and the antenna, so that the box can be mounted at any angle to fender, cowling, or other convenient part of the body.

Sec. C9.105 Mobile Antenna Tuning, 3000 Kc

After the antenna, matching unit, and line have been installed and connected according to directions, turn on the receiver and tune receiver to operating frequency of transmitter. Adjust C-17 for maximum noise output from receiver. There should be a very definite peak of noise output at some setting of C-17. Next switch transmitter on. Turn C-10 to about three-quarters of maximum capacitance, and adjust C-9 for minimum final plate current.

If plate current is then less than "normal" as stated in the instructions for operating supplied with the transmitter, reduce capacitance of C-10 and re-adjust C-9 for minimum plate current. Repeat this procedure until plate current is correct. If plate current is more than "normal," increase capacitance of C-10, then retune C-9 for minimum plate current. It may be necessary to add fixed capacitance in parallel with C-10. If so, a .00025 or .005 mf 2500-volt mica capacitor should be connected in the position of C-16 in Fig. 1. In any case, an adjustment of C-10 is sought such that when C-9 is adjusted for minimum plate current, that minimum current will be the "normal" plate current for the transmitter. For the Type I, Model B, "normal" plate current is 50 milliamperes.

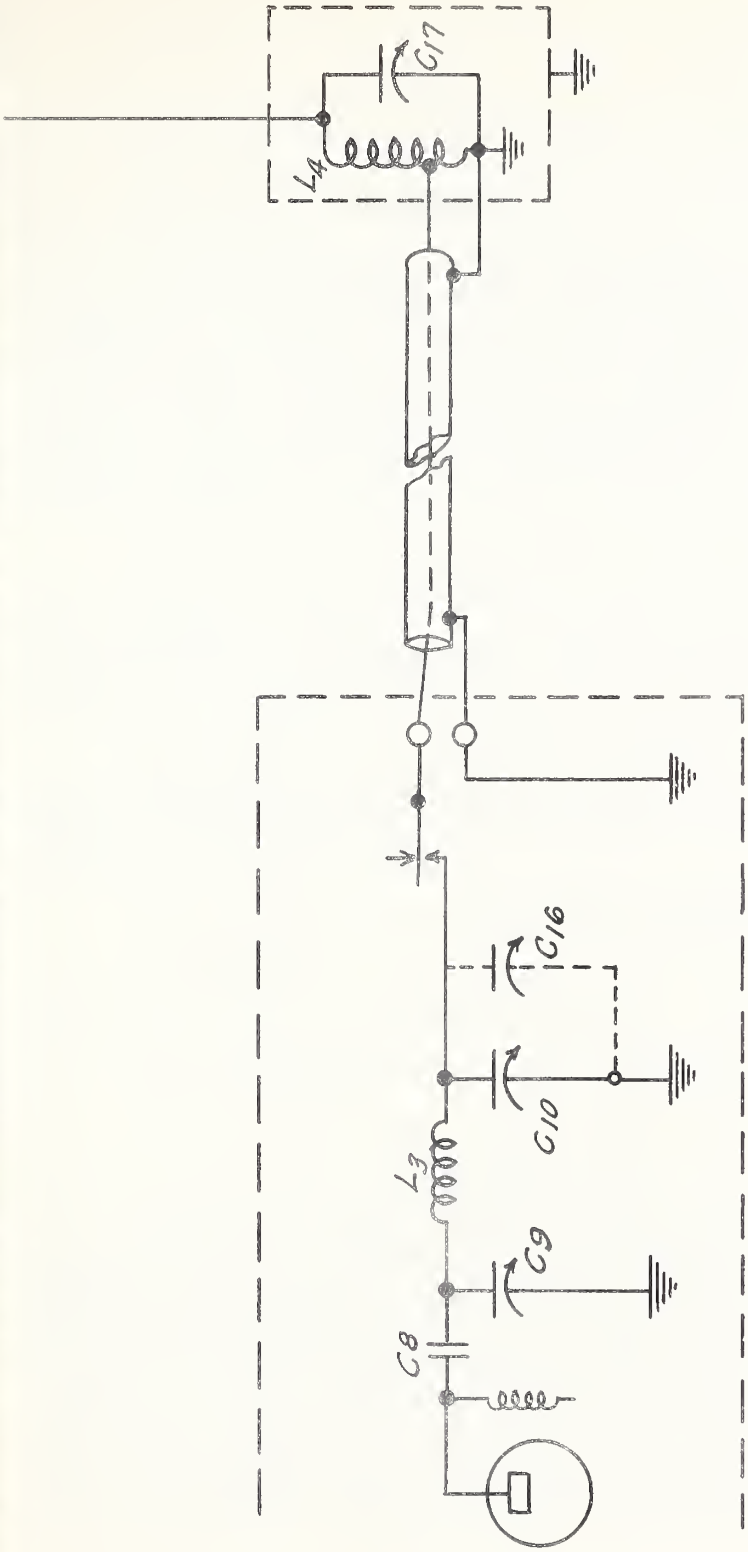


FIG. I
MOBILE ANTENNA INSTALLATION

The adjustment of C-9 is always the last adjustment made.

Sec. C9.106 Directional Antennas, 3000 Kc

Sometimes a particular path is encountered over which it is difficult to get satisfactory communication with the low-powered transmitters at hand. In some cases an increase in transmitter power can be avoided by use of a directional antenna, which, in effect, concentrates the radiated energy in a beam directed at the receiving station. The use of the directional antenna is to be preferred to increased power, because of the reduction of interference with other services sharing the Forest Service frequency assignments.

Among the types of directional antennas suitable for the band 2952 to 3445 kc may be listed the resonant V, non-resonant V, diamond (or rhomboid), and harmonic wire arrays. Descriptions of these and other directional antennas and their radiation characteristics will be found in the references listed at the end of this section.

In the case of the resonant V and the harmonic wire antennas, each consists of a combination of long wires, each wire being an integral number of half-wavelengths long. Formulas for the physical length of such wires follow:

For a simple half-wave antenna, the length is:

$$\text{Length (feet)} = \frac{468}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

For a harmonic wire N half-wavelengths long, the length is:

$$\text{Length (feet)} = \frac{(N - 0.05) \times 492}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Among the factors that will need to be considered when contemplating the erection of a directional antenna are cost, antenna gain, type of transmission line from transmitter to antenna, type of matching network between transmission line and antenna, and procedure for tuning. It is not possible to present sufficient information here to enable the field technician to give adequate consideration to these factors in solving the problems that may arise. Correspondence with the Radio Laboratory is therefore invited. Mail should be addressed to the Regional Forester, Box 4137, Portland, Oregon.

Sec. C9.200 Antennas, 30 Mc

Sec. C9.201 End-fed Half-wave Antennas, 30 Mc

Where ability to set up quickly is important, the half-wave end-fed antenna is provided. This type is supplied with portable Types SX and S Radiophones. The antenna length corresponds with a frequency in the middle of the band over which the equipment operates. Although performance is best at the frequency for which the antenna is a half wave, operation is acceptable on other frequencies covered by the Radiophone.

Formula (1) for the length of a half-wave antenna is given in the preceding section. For the Type SX Radiophone this length is 13 feet, 6 inches. This figure may also be used advantageously to replace the slightly greater length formerly recommended for the Type S.

Sec. C9.202 Half-wave Doublet Antennas, 30 Mc

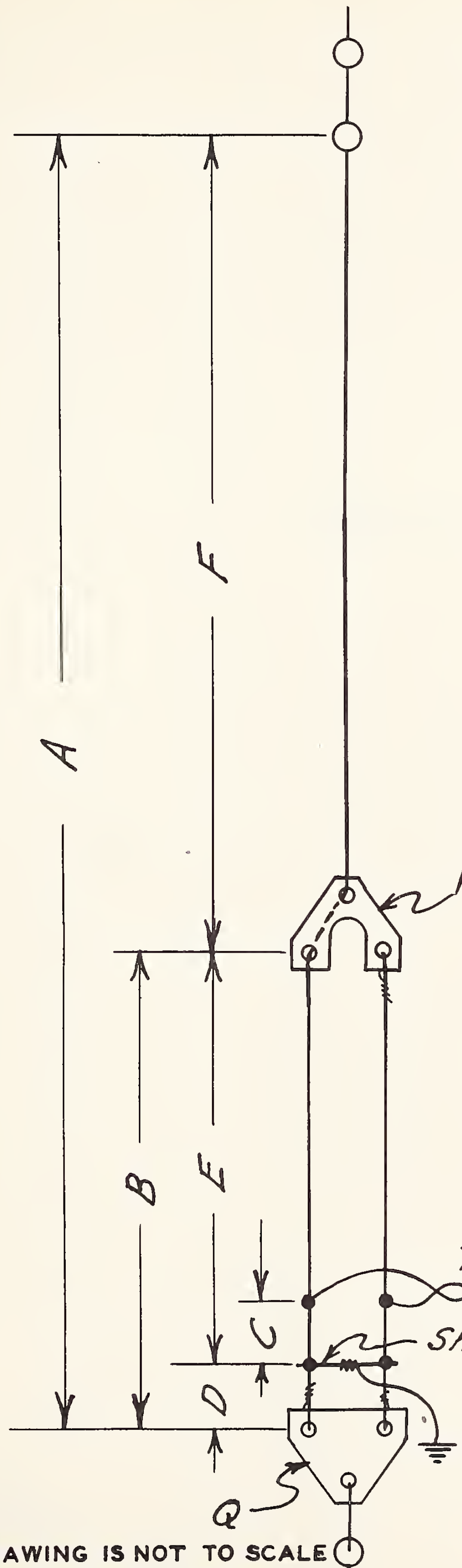
Center-fed doublet antennas were supplied with former models of the Type T Radiophone (Models CA, CB, and CC). This antenna consists of a half wave length of #14 enamelled wire, broken in the center with an insulator, where it is center fed with a 70-ohm twisted pair transmission line.

The approximate length of this antenna is given by formula (1) in Sec. C9.106. The length may be adjusted more accurately by the procedure outlined in Sec. C12.301, Type A Test Set, Item 2.01.

Sec. C9.203 Type J Antennas, 30 Mc

Although the Type J Antenna is not ideal electrically, its light weight and low cost adapt it to semi-portable applications. Where maximum efficiency is desired and portability is not a factor, the Type PD Antenna described in Sec. C9.204a is recommended.

The Type J Antenna is frequently used with Types SV, SX, and T Radiophones. It consists essentially of a vertical half-wave radiator which is matched to a low-impedance transmission line by means of a quarter-wave matching section. The radiator and matching section are made of #14 copper wire. In the past a twisted-pair transmission line has been supplied, but at present a flexible concentric line is used. Constructional details are sketched in Fig. 2, which is not to scale. Dimensions A and B must correspond with the transmitter frequency, as tabulated in Table 3.



NOTE: DRAWING IS NOT TO SCALE
SEE TABLE III FOR
DIMENSIONS "A" AND "B".

FIG. 2
TYPE J ANTENNA
COPPER WIRE MODEL

Delete Fig. 3

TABLE 3

ANTENNA AND MATCHING UNIT DATA FOR ULTRA-HIGH FREQUENCIES

Frequency kc	A* ft.	A* in.	B* ft.	B* in.
32,260	22	2¼	7	7½
32,300	22	1¼	7	7½
32,340	22	1	7	7¼
32,380	22	0½	7	7¼
32,540	21	11½	7	6-3/4
32,580	21	11	7	6-3/4
32,620	21	10-3/4	7	6½
32,700	21	9-3/4	7	6½
32,740	21	9½	7	6¼
32,780	21	9½	7	6
32,820	21	9	7	6
34,180	20	10-3/4	7	2½
34,220	20	10½	7	2¼
34,260	20	10	7	2¼
34,300	20	9-3/4	7	2
34,380	20	9	7	2
34,420	20	9	7	1-3/4
34,460	20	8-3/4	7	1-3/4
34,580	20	7-3/4	7	1½
34,620	20	7½	7	1¼
34,660	20	7¼	7	1¼
34,700	20	7	7	1
36,380	19	7½	6	9¼
36,420	19	7¼	6	9
36,460	19	7	6	9
36,620	19	6	6	8½
36,660	19	5-3/4	6	8½
36,700	19	5½	6	8½
36,740	19	5¼	6	8½
36,780	19	5	6	8¼
36,820	19	4-3/4	6	8¼
36,940	19	4	6	8
36,980	19	3-3/4	6	8
38,340	18	7½	6	5
38,380	18	7¼	6	5
38,420	18	7	6	5
38,540	18	6¼	6	4½
38,580	18	6	6	4½
38,620	18	6	6	4½
38,660	18	5½	6	4½
38,740	18	5¼	6	4¼
38,780	18	5	6	4
38,820	18	4-3/4	6	4
38,860	18	4½	6	4

Where:

$\frac{\lambda}{2}$ Antenna $= \frac{468}{f_{Mc}}$

$\frac{\lambda}{4}$ Matching Section $= \frac{246}{f_{Mc}}$

*See drawing of type J antenna.

Radio Hdbk.

The formula for the half-wave antenna portion of these structures is formula (1), given above in Section C9.106. The formula for the length of the quarter-wave matching section is as follows:

$$\text{Length (feet)} = \frac{246}{\text{Frequency (Mc)}} \quad \dots\dots\dots\dots\dots\dots\dots\dots (3)$$

The adjustment procedure is outlined in the following Sec. C9.204.

On lookout towers surrounded by a cat walk, one possibility of installation is the erection of a mast, 15 or 20 feet high, fastened to a support of the handrail as shown in Fig. 4. This will support the single-wire section, which should be kept at least 8 inches from the supporting mast. The free end of the wire should be supported by its insulator from a short horizontal member at the top of the mast. The 2-wire section should be stretched tight so that the individual wires are parallel and separated from the horizontal handrail by at least 8 inches. The rubber-covered cord may be run under the walk, and into the cab through a hole in the floor. Obviously, the mast must be installed in such a manner as to withstand any winds which may arise.

The installation scheme shown on Fig. 5 is applicable to lookout stations located on comparatively tall towers. If the supporting tower is steel, the single-wire section of the antenna should clear the tower by at least 6 feet. The antenna should be located on the side of the tower toward the stations with which communication is desired. On extremely tall towers it is permissible to stretch both single-wire and 2-wire sections down the side of the tower, as shown in Fig. 6. In any case the 2-wire section must be stretched tight so that the individual wires are parallel and separated from large surfaces by at least 8 inches, and the single wire should clear the tower by 6 feet or more.

In any of the above schemes of installation, if the rubber-covered cord is longer than necessary to reach to the radiophone, excess length may be cut off. However, if it is expected that the antenna may be subsequently installed at another location where the full cord length may be needed, it is preferable to coil up the excess length and tie it with string. The short wire connecting the two conductors of the 2-wire section near the bakelite triangle should be connected to the lightning-protection ground system of the tower with heavy copper wire.

A "J" antenna made of galvanized iron pipe and fittings was formerly recommended for permanent installation on buildings. Due to mechanical and electrical shortcomings of this pipe model, it is superseded by the Type PD Antenna, described in Sec. C9.204a.

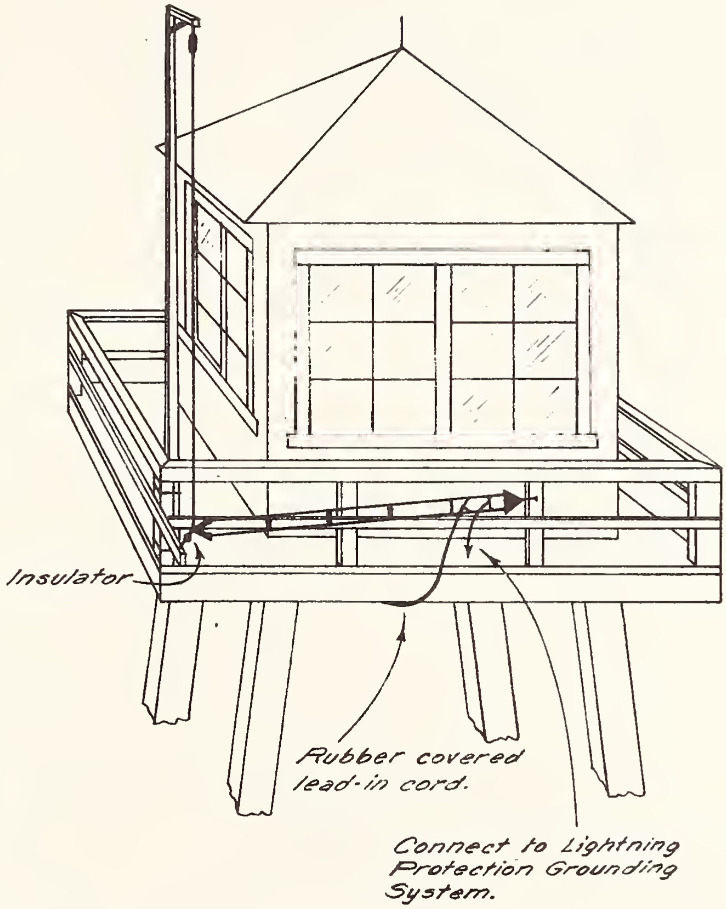


FIG. 4

TYPICAL ANTENNA INSTALLATION

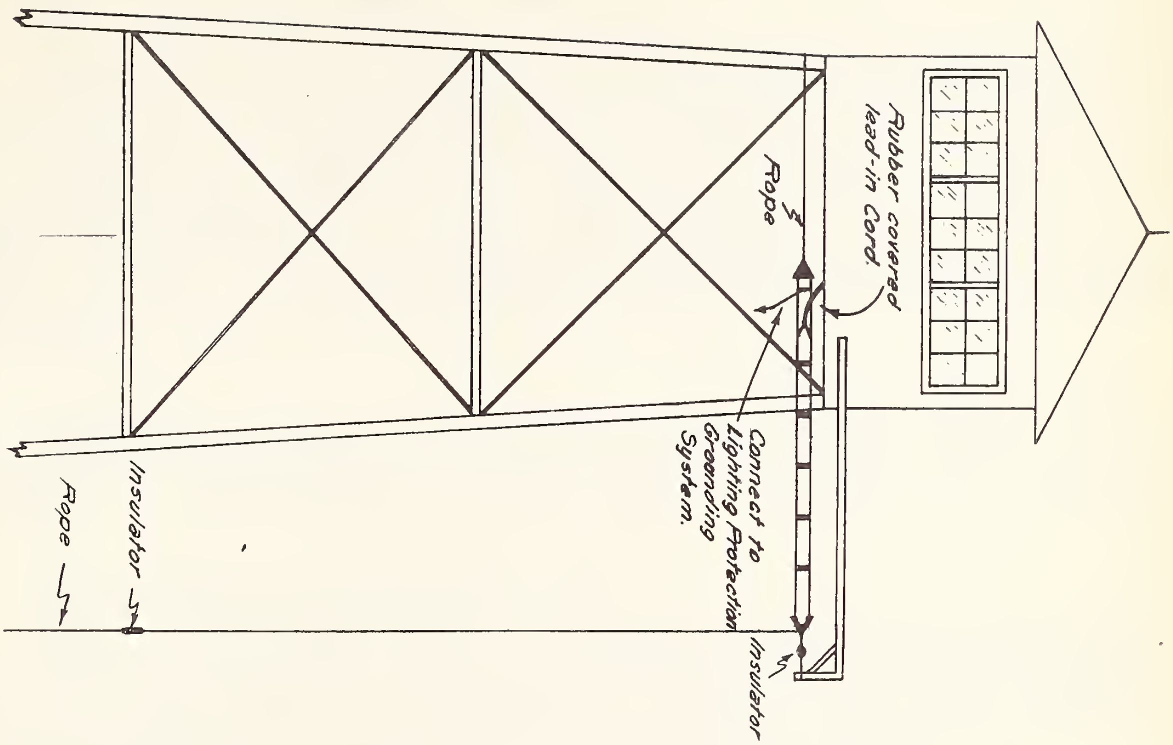


FIG. 5
TYPICAL ANTENNA INSTALLATION

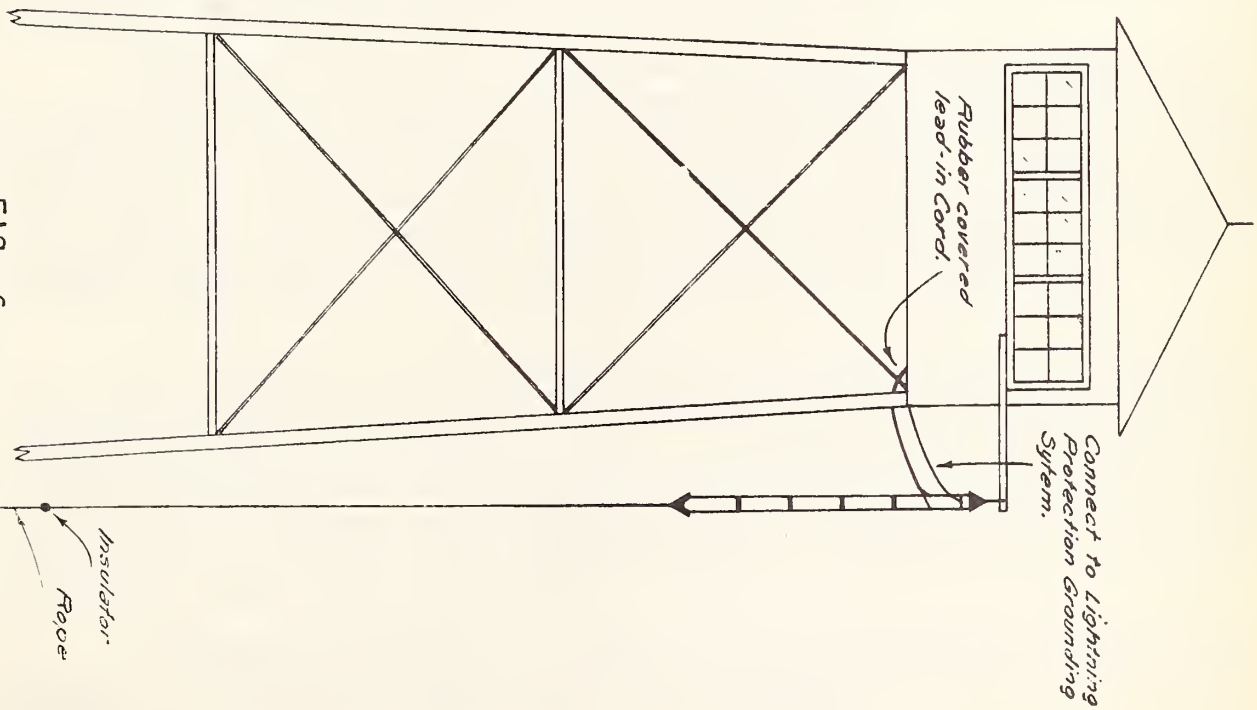


FIG. 6
TYPICAL ANTENNA INSTALLATION

Sec. 09.204 Type J Antenna Tuning, 30 Mc

After the antenna has been constructed and installed according to Fig. 2 and Table 3, the first adjustment to be made is the position of the shorting bar. With the transmission line disconnected, a position of this bar is sought such that the resonant frequency of the antenna, as measured with a grid-dip meter coupled near the shorting bar, is the operating frequency of the transmitter. Too long a matching section will cause the resonant frequency to be low, and too short a section will cause the frequency to be high. If no grid-dip meter is available, the shorting bar should have a position such that, referring to Fig. 2, dimension E is one-half of dimension F.

Dimension C of Fig. 2, the distance between the shorting bar and the point of attachment of the transmission line, is not highly critical. For a twisted pair or concentric line, C should be about 6 inches. For an open wire line made of two #12 conductors spaced 2 inches, C should be about 18 inches.

Sec. 09.204a Type PD Antenna, 30 Mc

The Type PD antennas, Model A, is a rugged and efficient u-h-f radiator, applicable to permanent installation on buildings. It will withstand normal wind and ice loads, and can be grounded for lightning surges without impairing its usefulness. It is constructed from galvanized iron pipe and fittings, using tools and skills usually at hand in garages and workshops.

Reduced to barest essentials, the Type PD consists of a vertical radiator, slightly less than a quarter wave in electrical length, working against a ground established by 4 horizontal quarter-wave radials.

Referring to Fig. 7, it is seen that the vertical section consists of a central conductor, connected at its lower end to the junction of the horizontal radials. A concentric skirt surrounds the lower portion of the central conductor, the connection between the two being at the top of the skirt. When the structure is proportioned properly, the base impedance as measured between the bottom of the skirt and the junction of the horizontal radials is approximately 70 ohms, with substantially no reactive component. This provides the desired termination for a low-impedance concentric transmission line.

The electrical functioning of the antenna may be understood from the following considerations. An antenna less than a quarter wave in electrical length presents a base impedance with resistive and capacitive components. The outer skirt and central conductor form a transmission line, shorter than one-quarter wavelength, and short-circuited at the far end. The inductive reactance of this line resonates the capacitive component of the antenna impedance. The net result is a resistive base impedance which, by suitable choice of antenna dimensions, can be made approximately 70 ohms.

Constructional details are shown in Fig. 8, the working drawing, and Figs. 9, 10 and 11, photographs showing the assembly, details of supports for radials, and details of transmission-line termination.

USFS RADIO LAB DRWG
PD-A-41-B
FORM RL-4

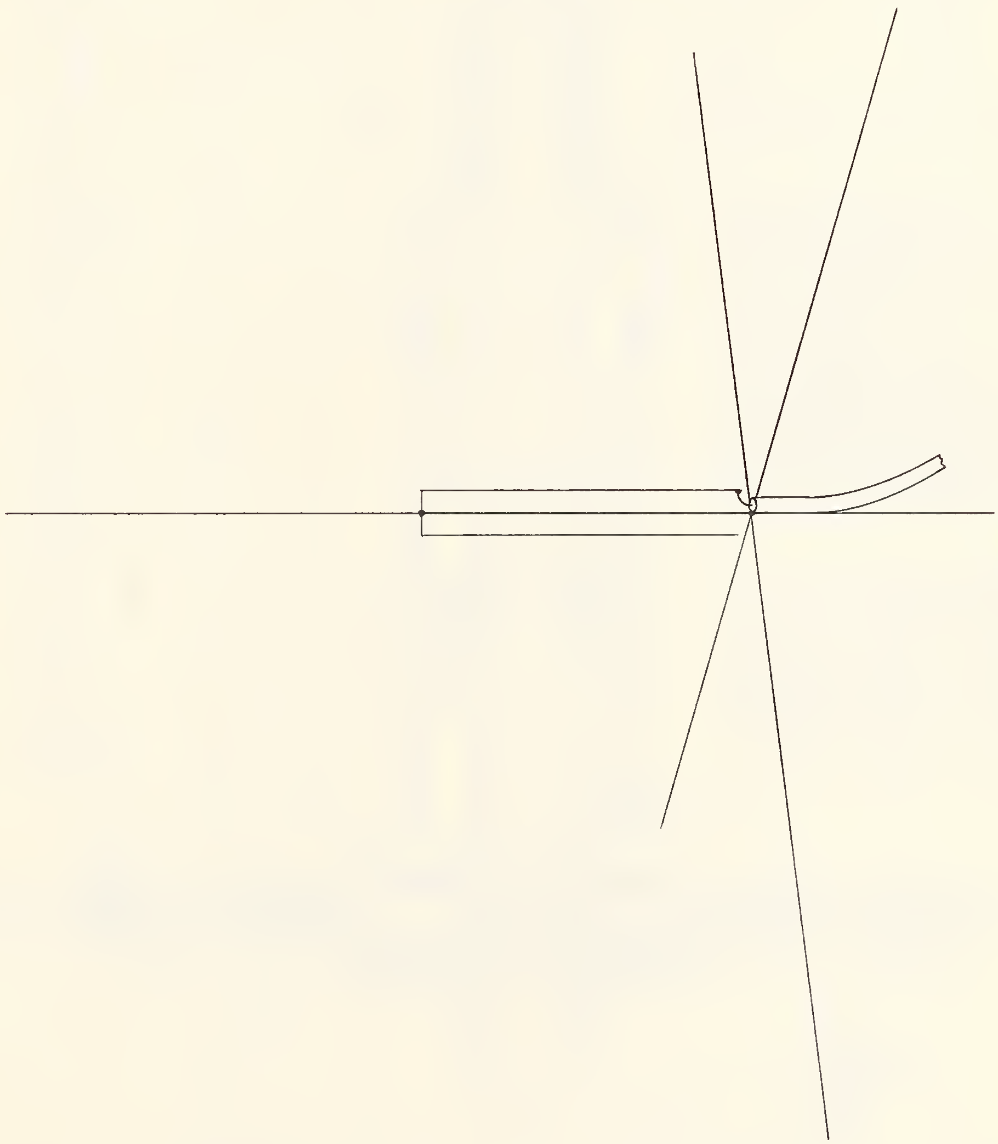
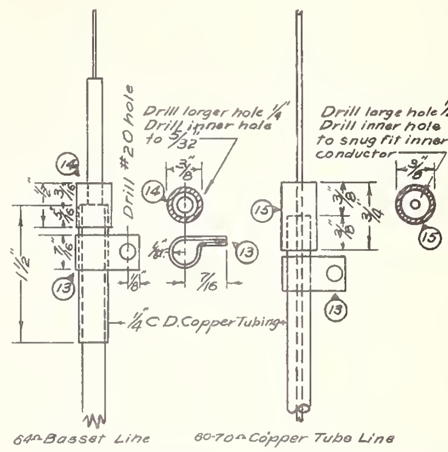
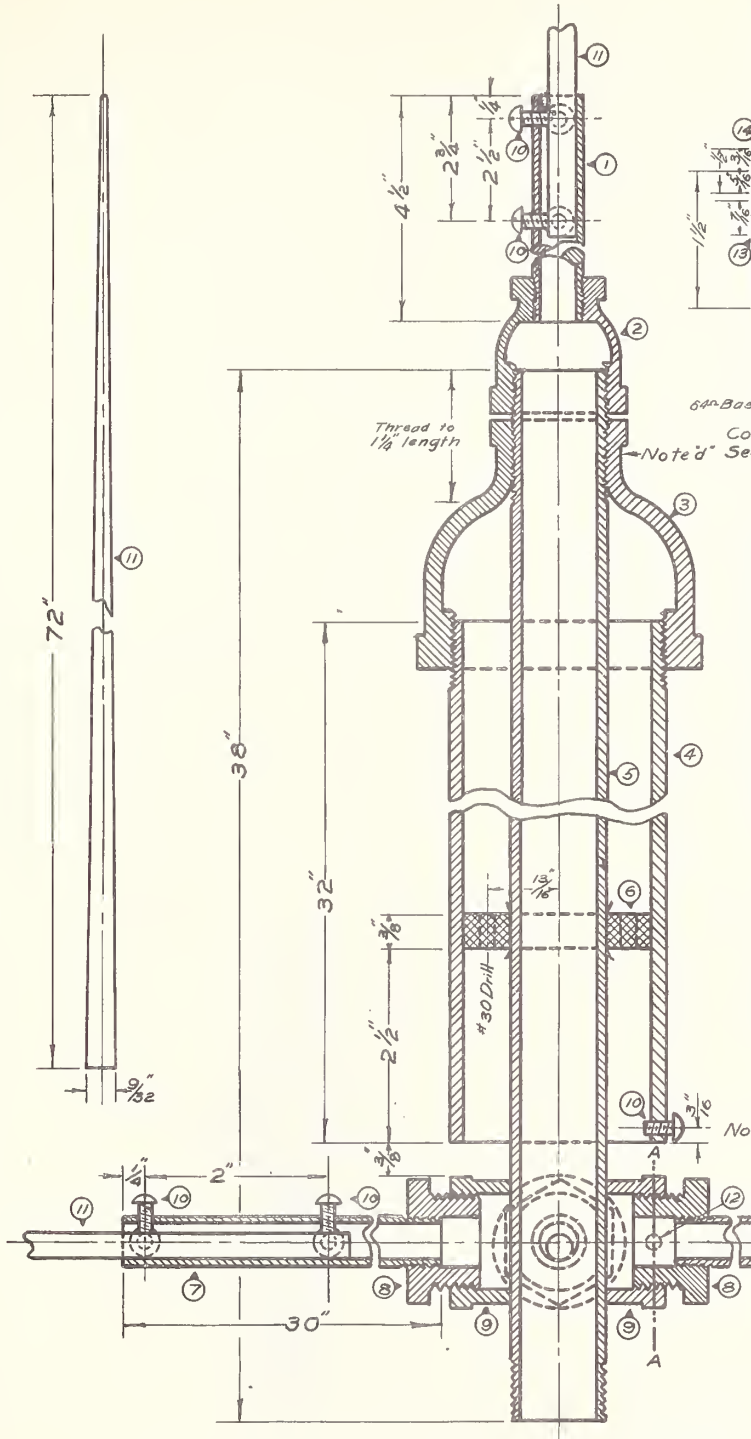


FIG. 7
SKETCH OF TYPE PD ANTENNA, MODEL A



Concentric Line Clamp & End Seal Detail
See Photo & Descriptive Sheets - -

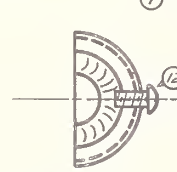


MATERIAL LIST			
Item	Quan	Description	Mat.
1	1	1/4" Pipe	G.I.
2	1	3/4" to 1/4" Bell Reducer	G.I.
3	1	2" to 3/4" " " (Note "d")	G.I.
4	1	2" Pipe	G.I.
5	1	3/4" "	G.I.
6	1	3/8" Disc (Note "a")	Micarta
7	4	1/4" Pipe	G.I.
8	4	3/4" X 1/4" Red. Bushing	G.I.
9	1	3/4" Cross (Note "b")	G.I.
10	21	8-32 X 3/8" Cad. Plated Screw	Iron
11	5	American Fork & Hoe — 6 Ft. Cadmium Plated Antenna Rods	Steel
12	1	8-32 X 3/8" Screw (Note "c")	Iron
13	1	Clamp #18 Guage	Copper
14	1	End Seal - 3/8" Polystyrene	Rod
15	1	" " " "	"

Critical Lengths

Frequency in M. C.	Radial Lengths from 3/4" pipe C.L. to tip of rod	Vertical Lengths from bottom of 2" pipe to tip of rod
32.0 to 33	8' 3"	9' 0"
34.0 to 35	7' 9 1/2"	8' 5"
36.0 to 37	7' 4"	7' 10 1/2"
38.0 to 39	7' 1/2"	7' 5 1/2"
39.50	6' 11"	7' 4"

FIG. 8



Sec. A-A

Notes:

a - Micarta disc to be O.D for loose fit inside 2" G.I. pipe & I.D. for snug fit over 3/4" G.I. pipe. Burr pipe above & below with cold chisel to hold in place. Drill 6 #30 holes equally spaced from center.
b - 3/4" Cross to be drilled for snug fit on O.D. of 3/4" pipe & sweated to it to dimensions specified.
c - Screw should be diagonal to cross on same side as screw 12.
d - Run 3/4" pipe tap completely through 3/4" end of Bell to remove taper.

U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE

UHF ANTENNA

TYPE PD
MODEL A

DRAWN BY C. W. MCP. CHECKED BY H.K.L. DATE AUG. 26, 1941	USFS RADIO LAB DRWG PD-A-31-B

FORM RL-3

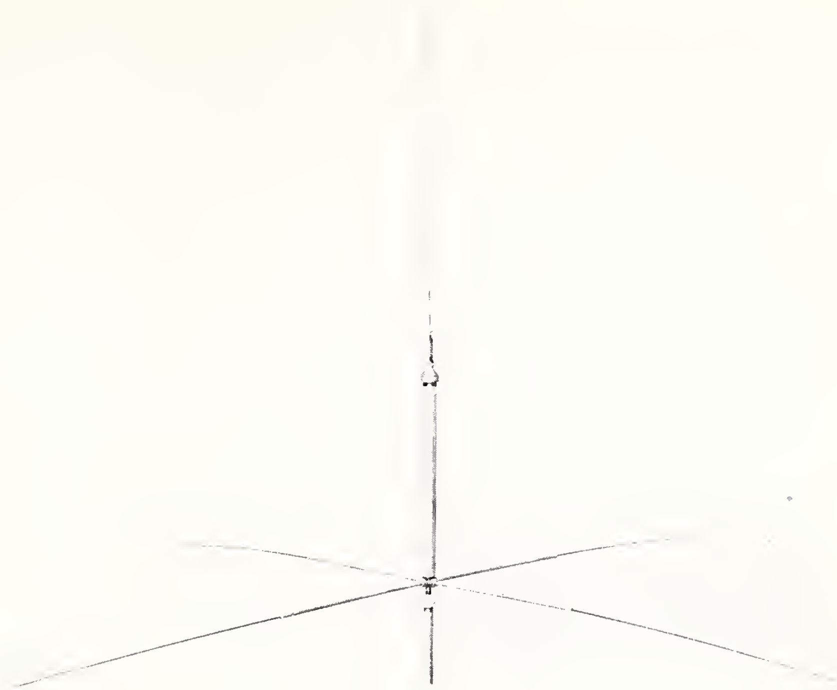


FIG. 9. TYPE PD ANTENNA, MODEL A

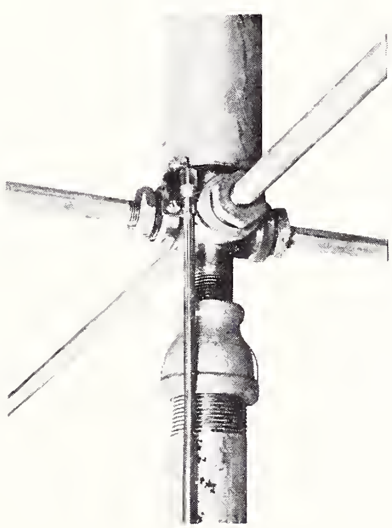


FIG. 10. DETAILS OF RADIALS SUPPORT

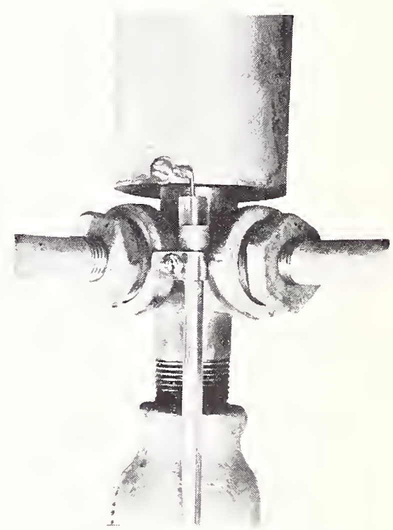


FIG. 11. DETAILS OF TRANSMISSION-LINE TERMINATION

Sec. C9.205 Mobile Antennas, 30 Mc

An efficient and practicable mobile antenna for the 32 to 39 Mc frequency band is the quarter-wave vertical fishpole. The formula for the length of the quarter-wave antenna is as follows:

$$\text{Length (feet)} = \frac{246}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Theoretical considerations show that the base of this antenna should present a resistive impedance of 36 ohms to ground. Thus it is proper to use a transmission line whose surge impedance is near 36 ohms, such as Bassett Type BCF-34-1000. The inner conductor of the transmission line is connected to the base of the antenna, and the outer conductor is grounded to the car body at a point near the antenna base.

Sec. C9.206 Directional Antenna Arrays, 30 Mc

It is possible to increase the intensity of radiation in a given direction at the expense of radiation intensity in other directions. There are numerous methods of accomplishing this result. The one chosen will depend upon the nature of the communication to be provided, the availability of space for complex antenna structures, and the availability of instruments for delicate tuning adjustments. Possibly the easiest type of directional antenna to fit into most conditions encountered is one which makes use of parasitic reflectors, parasitic directors, or both.

In a typical installation making use of reflector and director, the antenna itself would be a Type J vertical half-wave wire. The reflector would be another wire, slightly longer than a half-wave in length, parallel to the antenna, and spaced one-quarter wave behind the antenna (i.e., in the direction away from the station with which communication is desired). The director would be a third wire, slightly shorter than a half-wave in length, also parallel to the antenna, and spaced three-eighths wave in front of the antenna. A second director wire may be added three-eighths wave in front of the first director, and a third may be added three-eighths wave in front of the second, and so on.

Directivity can be improved further by addition of side reflector wires. These wires are spaced one-half wavelength from the radiating antenna, in a direction at right angles to the desired radiation, one reflector being placed on each side of the radiating antenna.

A radiating antenna may be augmented by a single rear reflector or by 1, 2, or 3 director wires, or by 2 side reflectors. Any combination of the above may be used. The use of the single rear reflectors, or 2 front directors, or 2 side reflectors will double the radiation in the desired direction. The use of any two of the foregoing will multiply the radiation by 4, and of all three by 8.

Formulas for reflector and director lengths, and for spacings, are stated in formulas (3), (4), (5), (6), and (7):

Spacing between Antenna and Rear Reflector:

$$\text{Spacing (feet)} = \frac{246}{\text{Frequency (Mc)}} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots (3)$$

$$\text{Reflector length (feet)} = \frac{480}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots (4)$$

$$\text{Director length (feet)} = \frac{427.6}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots (5)$$

Spacing between Antenna and Director:

$$\text{Spacing (feet)} = \frac{369}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots (6)$$

Spacing between Antenna and Side Reflector:

$$\text{Spacing (feet)} = \frac{492}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots (7)$$

Sec. C9.3 Antenna Impedance

An antenna exhibits resonant rises of current and voltage. Since the voltage maximum occurs at a point a quarter wavelength away from the current maximum, it follows that the ratio of voltage to current, i.e., the impedance, varies from point to point along the antenna. The impedance of an antenna therefore depends upon which point along the antenna we refer to.

If an antenna is an integral number of quarter waves long, its impedance will be a pure resistance, the magnitude of which varies along the length of the wire. In any other case the impedance has an inductive or capacitive component.

(*) Table 4 lists impedances of two common types of antenna.

Table 4. Antenna Impedances

Center-fed doublet	72 ohms
Quarter-wave vertical against ground	36 ohms

The impedance of end-fed horizontal antennas depends somewhat upon the height and the proximity to other objects. In general it can be stated that the impedance is higher when the length is an even number of quarter waves, and lower when the length is an odd number of quarter waves. Also, making due allowance for the foregoing statement, the higher the harmonic order of an antenna, the lower will be its impedance.

The practical importance of having at least an estimate of the antenna impedance is that such an estimate makes possible a wise choice of feeding system for the antenna.

Sec. C10.0 TRANSMISSION LINES

Sometimes it is convenient to energize the antenna directly from the transmitter. This is done when the end-fed antenna is used with Types S or SPF. Often, however, it is desirable to locate the antenna at a greater distance from the transmitter to provide adequate separation from ground and other objects. In such instances a transmission line carries the radio-frequency power from transmitter to antenna.

Conventional transmission lines are of two types, namely, open-wire and concentric (co-axial). The open-wire type consists of two parallel or twisted wires. The concentric type consists of an inner conductor, surrounded by a concentric outer conducting shell. In either case a suitable dielectric separates the two conductors.

The important characteristics of any transmission line are the surge impedance (characteristic impedance) and the attenuation factor. In general, the surge impedance will have slight variation with frequency, while the attenuation factor will have a moderate to large variation with frequency.

Sec. C10.1 Surge Impedance

Consider a transmission line of given type and physical dimensions and of random length. A variable non-inductive resistance is connected across the receiving end. A single value for this resistance can be found, such that the impedance measured at the sending end will be a pure resistance. The value of this resistance will be the same for any length of line, and for a wide range of frequencies. This resistance value is the surge impedance for the particular line involved. The symbol for surge impedance is Z_0.

When a transmission line is terminated with its surge impedance, and power is supplied at the sending end, there will be no standing waves of current or voltage. Both current and voltage will be maximum at the sending end, and will taper off gradually toward the receiving end. The rate of taper with length depends upon the attenuation factor. Since there are no resonant rises of voltage or current in a line operated in this manner, it follows that losses will be a minimum for transfer of a given amount of power. The foregoing statements apply also to a line terminated in a load, such as

an antenna, which presents to the receiving end an impedance that is a pure resistance of magnitude equal to the surge impedance of the line. It is to present exactly such an impedance to a line that antenna matching networks are designed and adjusted so carefully and that antenna lengths must be determined so closely.

Surge impedance of a line depends essentially upon physical dimensions and dielectric constant of the insulating medium. Formulas follow:

For transmission lines of any type, neglecting the slight effects of losses,

$$Z_o = \sqrt{\frac{L}{C}} \quad \text{(8)}$$

Where Z_o is the surge impedance in ohms,

L is line inductance per unit length in henries,

and C is line capacitance per unit length in farads.

For an open wire line with air insulation, surge impedance is

$$Z_o = 276 \times \left(\log_{10} \frac{b}{a}\right) \quad \text{(9)}$$

Where b is the wire spacing between centers,

and a is the radius of wire.

For a concentric line with air insulation, surge impedance is

$$Z_o = 138 \times \left(\text{Log}_{10} \frac{b}{a}\right) \quad \text{(10)}$$

Where b is the inner diameter of the outer conductor,

and a is the outer diameter of the inner conductor.

In formulas (9) and (10), b and a must be measured in the same units (e.g. inches) before substituting in the formula. The expression $(\text{Log}_{10} \frac{b}{a})$ means that after dividing b by a, one finds the common

logarithm (to the base 10) of the quotient. This logarithm is then multiplied by 276 or 138, as the case may be, to get the surge impedance. Tables of common logarithms may be found in any trigonometry text, or in any handbook of civil, mechanical, or electrical engineering.

For example, an open-wire line with #12 AWG conductors and 6-inch spacing will have a surge impedance of 600 ohms. A #10 conductor inside a 3/8 inch inside diameter sheath will have 120 ohms surge impedance.

A twisted pair line is a special case of open wire line, in which formula (9) does not apply because the insulation is not air. Similarly, formula (10) does not apply to concentric line with solid insulating material. Determination of surge impedance for these types is a laboratory job. Surge impedances for such lines normally are between 50 and
(*) 100 ohms, although line is commercially available with impedance as low as 3 ohms.

A special type of transmission line is the single wire feeder used with the half-wave antenna described in Section C9.101. The surge impedance of such a line is approximately 600 ohms.

A properly terminated transmission line will not contribute to the radiation of a transmitting antenna nor to the received signal of a receiving antenna.

Sec. C10.2 Attenuation Factor

In a line terminated in its surge impedance, voltage and current will be maximum at the sending end and will decay gradually as one goes toward the receiving end. In a properly designed and adjusted line, this reduction is negligible for the length of line involved in the usual installation. Current and voltage at any point along the line are given by the following formulas, which apply only to a line terminated in its surge impedance.

$$I = I_0 \, \epsilon^{-\alpha \ell} \quad \ldots\ldots\ldots\ldots \quad (11)$$

$$E = E_0 \, \epsilon^{-\alpha \ell} \quad \ldots\ldots\ldots\ldots \quad (12)$$

Where I and E are the current and voltage respectively at a point ℓ feet from the sending end,

I_0 and E_0 are the current and voltage respectively at the sending end,

ϵ (Greek letter Epsilon) is the base of Naperian logarithms ($\epsilon = 2.718$)

And α (Greek letter Alpha) is the attenuation factor.

In any line that is suitable for transmission of radio-frequency power, the attenuation factor is small enough so that it need not be considered in field installations, except possibly where the line is unusually long. Determination of attenuation factor for a particular type of line is a laboratory job.

Sec. C10.3 Resonant Transmission Lines

Transmission lines which are purposely terminated in other than surge impedance are known as resonant transmission lines. Such lines are not to be recommended for transfer of power from transmitter to antenna unless this function is combined with use of the line as an impedance matching network, as described below.

Among the more important uses of resonant lines are the frequency control of ultra-high frequency transmitters, and impedance matching networks. The familiar quarter-wave matching stub is an example of the second use listed and is the only application that will be discussed here.

Sec. C10.4 Quarter-wave Matching Stubs

If one end of a quarter wave line is short-circuited, the other end will appear to have a very high impedance, of the nature of a pure resistance. That is to say, if a high frequency voltage is applied to the open end, a small in-phase current will be measured at the open end. At the short-circuited end the voltage will be practically zero, and the current will be large, due to the resonant rise of current in the quarter-wave section. This is equivalent to saying that at the short-circuited end the impedance is zero, since there is a large current and no voltage. Thus we have a condition of high impedance at the open end, and practically zero impedance at the shorted end. At intermediate points along the line the impedance will vary between the open end value and zero. It will be progressively smaller as one moves toward the shorted end. A high impedance r-f power source could be connected to the open end, and a low impedance load connected at a suitable point along the line. Or the procedure could be reversed. A high impedance load, such as an end-fed half-wave wire could be matched to a low impedance source, such as a transmission line. In this case the high impedance load is connected to the open end of the line, while the low impedance source is connected at a suitable point along the line. If the matching procedure is carried out correctly, the load presented to the transmission line will have the characteristic of a pure resistance equal in magnitude to the surge impedance of the line.

Briefly, this procedure amounts to (a) adjusting the total length of the matching stub so that its electrical length is exactly one-quarter

wavelength, and (b) connecting the transmission line at such a point that the impedance which the transmission line sees is its surge impedance.

To accomplish these adjustments in the field, disconnect the transmission line from the matching stub. Connect the antenna to the open end of the matching stub. Connect the shorting bar in a trial position, such that the matching section has a length approximately as given by Formula (3). Measure the resonant frequency of the structure by coupling a grid-dip oscillator near the shorting bar. If the frequency is too high, the matching section should be lengthened by moving the shorting bar. If too low, the section must be shortened.

Connect the transmission line to the stub at a trial point. For a twisted pair line, this line might be 6 inches from the shorting bar for the 30 to 40 Mc band, and perhaps 10 times greater distance for the 3000 kc band. For an open wire line, these distances will be somewhat greater.

If an open wire transmission line is used, connect the line to the transmitter and adjust the transmitter for resonance and proper loading. Next make comparative current measurements along the transmission line. This can be done by connecting the terminals of a radio-frequency milliammeter to two wire hooks about 18 inches apart. With these hooks hung on one uninsulated wire of the transmission line, the meter will indicate a certain portion of the total current. The meter assembly is hung at various points along the transmission line, and the current indications at the various places are noted. If the current varies along the line, it indicates that the transmission line is tapped on the stub at the wrong place, and a new tap point must be tried. After making the new trial connection, re-adjust the transmitter and again measure current along the line. If current variations have decreased, the tap point was moved in the correct direction. If they have increased, the tap should be moved in the opposite direction. Repeat the procedure until the current is uniform along the line.

In the case of the twisted pair or concentric line this method cannot be used. Insert an r-f ammeter in the antenna at a current maximum; i.e., at a point an odd number of quarter-wavelengths from the open end of the antenna. Adjust the point of connection of the transmission line on the matching stub for maximum r-f antenna ammeter reading, keeping the power delivered by the transmitter constant. That is, for each trial, the coupling between transmitter and line is adjusted so that when the final stage is resonated, final plate current dips to a standard value. Antenna current for the trial connection is then read.

Sec. C11.0 FORMULAS

Length of simple half-wave antenna:

$$\text{Length (feet)} = \frac{468}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots \quad (1)$$

Length of harmonic wire N Half-wavelengths long:

$$\text{Length (feet)} = \frac{(N - 0.05) \times 492}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots \quad (2)$$

Length of quarter-wave antenna, quarter-wave matching stub, or separation between antenna and rear reflector:

$$\text{Length (feet)} = \frac{246}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots \quad (3)$$

Reflector length:

$$\text{Length (feet)} - \frac{480}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots \quad (4)$$

Director Length:

$$\text{Length (feet)} = \frac{427.6}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots \quad (5)$$

Separation between antenna and director:

$$\text{Spacing (feet)} = \frac{369}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots \quad (6)$$

Separation between antenna and side reflectors:

$$\text{Spacing (feet)} = \frac{492}{\text{Frequency (Mc)}} \quad \ldots\ldots\ldots\ldots \quad (7)$$

Surge impedance, any transmission line:

$$Z_o = \sqrt{\frac{L}{C}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Where Z_o is surge impedance in ohms,

L is inductance per foot in henries,

C is capacitance per foot in farads.

Surge impedance, open wire line with air insulation:

$$Z_o = 276 \times (\mathrm{Log}_{10} \frac{b}{a}) \quad (9)$$

Where Z_o is surge impedance in ohms

b is the wire spacing in inches

a is the wire radius in inches

Surge impedance, concentric line with air insulation:

$$Z_o = 138 \times (\mathrm{Log}_{10} \frac{b}{a}) \quad (10)$$

Where Z_o is surge impedance in ohms

b is inner diameter of outer conductor in inches

a is outer diameter of inner conductor in inches

Meters to feet

Feet = 3.28 x Meters . . . . (13)

Meters to inches

Inches = 39.37 x Meters . . . . (14)

Centimeters to inches

Inches = 0.394 x Centimeters . . . . (15)

Inches to centimeters

Centimeters = 2.54 x Inches . . . . (16)

Sec. C11.1 References

The foregoing discussion of antennas and transmission lines is necessarily brief and sketchy due to the vastness of these subjects and the limited space available here. It is urged that the field technician extend his information on these important subjects. A list of references is given herewith:

The Radio Amateur's Handbook, Chapter on Antennas	American Radio Relay League, Hartford, Conn., $1.00
The Radio Handbook Chapter on Antennas	Radio, Ltd., 7460 Beverly Blvd., Los Angeles, Calif., $1.50

Radio Engineering Chapter on Antennas — Terman, F. E., McGraw Hill Publishing Co., 1937 Ed.

Sec. C12.0 SERVICE EQUIPMENT

The following section is for the guidance of the technician and administrative man in the matter of selection of service equipment necessary to maintain Forest Service radio equipment.

It should be understood that the amount and kinds of service equipment necessary to keep Forest Service radiophones in top operating condition are entirely dependent upon the types of radio sets in use. However, there is the ever-present factor of the economic angle, which may dictate that a light radio investment does not justify a complete line of service equipment even at the sacrifice of peak operating efficiency of the radio apparatus.

A trained radio technician can maintain the radiophones in passable operating condition with what has been listed as Basic Test Equipment (12.100). This equipment will permit satisfactory maintenance and correction of all faults resulting from actual failure of component parts or wiring but will not permit the precise adjustment necessary for peak performance in such sets as the Types SPF, M and I.

Every Forest or Regional technician will require Basic Test Equipment regardless of the quantity of radio sets on hand, while those Regions with a heavy radio investment and suitable technical personnel will find the complete list of suggested equipment (C12.200) invaluable in realizing the fullest efficiency from their radio apparatus.

Sec. C12.100 Basic Test Equipment

C12.101 Combination a-c d-c Voltmeter Milliammeter, 1000 or more ohms per volt on voltmeter scales. An instrument with 20,000 ohms per volt on the d-c scales is to be preferred. Suggested full scale ranges are 2.5, 10, 50, 250, and 1000 volts, and 1, 10, 50, and 250 milliamperes.

C12.102 Tube checker.

C12.103 USFS Type A Test Meter. This is a combination grid-dip oscillator and rectifier wavemeter which operates over 2 frequency ranges, 2.9 to 3.5 Mc, and 28 to 42 Mc.

Sec. C12.200 Supplementary Test Equipment for USFS Radiophones

C12.201 Type I Radiophone

Signal Generator, 2.9 to 3.5 Mc, and 465 kc
Output Meter

C12.201 Type I Radiophone (Cont'd)

Oscilloscope, Cathode Ray
Hydrometer

C12.202 Type M Radiophone

Signal Generator, 2.9 to 3.5 Mc, and 465 kc
Output Meter
Oscilloscope, Cathode Ray

C12.203 Type SPF Radiophone

Signal Generator, 2.9 to 3.5 Mc, and 465 kc
Output Meter
Oscilloscope, Cathode Ray

C12.204 Type A Radiophone

Oscilloscope, Cathode Ray
Hydrometer

C12.205 Type S Radiophone

Requires only Basic Test Equipment
(See C12.1-2-3)

C12.206 Type SV Radiophone

Requires only Basic Test Equipment
(See C12.1-2-3)

C12.207 Type T. Radiophone

Models CA, CB, CC

Heterodyne Frequency Meter, 30 to 40 mc
Oscilloscope, Cathode Ray

Model D

Signal Generator, 4050 kc
USFS Type D Frequency-Modulated Oscillator
Oscilloscope, Cathode Ray

(*)C12.208 Type K Radiophone

Signal Generator, 2.9 to 3.5 Mc, and 262 kc
Output Meter
Oscilloscope, Cathode Ray
Hydrometer

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

RADIO SERVICE REPORT FORM

Type______ Serial______ Date______ Forest__________ Location__________

TUBES

Transmitter Type		Receiver Type	
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)

BATTERIES

A Battery No. __________
Number used __________
Voltage __________
B Battery No. __________
Number used __________
Voltage __________
C Battery No. __________
Voltage __________

- -

TRANSMITTER

Filament Voltage ________ v.
Final Plate Current ________ Ma.
Osc. Plate Current ________ Ma.
Grid Current ________ Ma.
Neutralization ________
Frequency ________ Mc.
General Condition ________
Modulation ________
Meter Condition ________

RECEIVER

Filament Voltage ________
Plate Current Drain ________
Frequency Coverage____Mc.to______Mc.
Sensitivity (listening) ______
General Condition ______

GENERATOR

Serial No. ______
Brushes ________ Gas Engine ______
Wiring ________ Cleaning ______

- -

ANTENNAS

Dimensions ________
Condition of Wire ________
Connections ________
Insulators ________
Sash Cords ________
Portable Reels ________
Kit Bag Contents ________

REPAIR PARTS

____
____
____
____
____
____
____

General remarks and recommendations: ________________
____
____
____

Radio Hdbk.

Signed: ________________

C12.300 SERVICE INSTRUMENTS

Radio Hdbk.
Added 10-16-39
No. 1

C12.301 Type A Test Set

Instructions for Operating

Miscellaneous Notes

TYPE A

Model A Nos. 1 to #3 Inc.

Model AA Nos. ~~5~~4 to 13 Inc.

Model ~~A~~B Nos. 14 to 16 Inc.

Model B Nos. 17 to Inc.

Model Nos. to Inc.

Radio Hdbk
Added 10-16-39
No. 1

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0.0 GENERAL DESCRIPTION

The USFS Type A Test Set is a compact multi-purpose instrument, which may be operated as a grid-dip oscillator, a modulated oscillator, or a rectifier wavemeter. Numerous servicing jobs may be performed with the aid of the Type A Test Set. Among the more important of these may be listed the following:

(a) Adjustment of antenna and matching section lengths.

(b) Neutralization of r-f amplifiers in transmitters.

(c) Test for existence and approximate frequency of oscillations in transmitters and receivers.

(d) Audible check of transmitter modulation.

(e) Measurement of approximate resonant frequency of tuned circuits.

(f) Monitoring of keying of c-w transmitter.

Although the Type A is not the equivalent of a signal generator with a calibrated attenuator, its modulated or unmodulated output may be used as a source of signal during certain receiver adjustments. The resourceful technician will find many other uses for this instrument.

The Type A Test Set is contained in a small hardwood case, and operates from self-contained dry batteries. Approximate weight is 5 lbs., and dimensions are 8-5/8" long x 6-1/4" high x 4-1/2" deep.

0.1 Frequency Range

With the 4 coils supplied, the Type A Test Set has the following frequency ranges:

High-Frequency Coils

Oscillator	2400 to 4000 kc
Rectifier Wavemeter	2200 to 4500 kc

Ultra-High-Frequency Coils

Oscillator	26 to 44 Mc
Rectifier Wavemeter	23 to 45 Mc

The 4 coils listed above may be idendified as follows:

High-Frequency Oscillator	2 windings, each #28 enameled wire, close-wound.
High-Frequency Rectifier Wavemeter	1 winding, #28 enameled wire, close-wound.
Ultra-High-Frequency Oscillator	2 windings, #20 enameled wire, spaced turns.
Ultra-High-Frequency Rectifier Wavemeter	1 winding, #20 enameled wire, spaced turns.

0.2 Models A and AA

The two models of the Type A Test Set which have been distributed are Type A Model A (Serial numbers 1, 2, 3), and Type A Model AA (Serial numbers 4 and higher). Model A uses a Type 30 tube, which has a 2-volt filament, while Model AA uses a Type 1E4G tube, which has a 1.4-volt filament. In the Model A filament voltage is adjusted by means of a rheostat with a screw-driver slot accessible on the panel. In the Model AA, the filament is connected directly across the 1.5-volt "A" battery. In both models the panel meter indicates filament voltage when "ON-OFF" switch is "ON", and "GRID-FIL" switch is turned to "FIL". Full-scale voltmeter reading is 4 volts on the Model A, and 2 volts on the Model AA. In the Model AA, a variable plate-dropping resistor provides panel control of oscillation amplitude, and thus of oscillator grid current. The knob for this plate resistor is located between the two switches. On the Model AA a variable mica compression trimmer capacitor is supplied, by means of which variations in tube inter-electrode capacitance may be compensated when it is necessary to change a tube.

1.0 OPERATION

1.1 Adjustment of Filament Voltage (Model A)

Before putting the Type A Model A Test Set (Serial numbers 1, 2, 3) into operation according to any of the following directions, filament voltage should be adjusted. Turn "ON-OFF" switch "ON", and "GRID-FIL" switch to "FIL". Turn screwdriver adjustment on panel so that meter reads 2.1 volts (0.525 on meter scale).

1.2 Grid-Dip Oscillator, Unmodulated

Insert oscillator coil for desired frequency range, turn "ON-OFF" switch "ON", and "GRID-FIL" switch to "GRID". On Model AA, adjust the knob between the two switches so that meter is well up on the scale, but not off scale. This knob controls plate voltage. Test Set will then operate as an unmodulated oscillator, with panel meter measuring oscillator grid current. Frequency of oscillations is adjusted with tuning dial, and is indicated by calibration.

1.3 Modulated Oscillator

Insert oscillator coil for desired frequency range, turn "ON-OFF" switch "ON", and "GRID-FIL" switch to "FIL". Test set will then operate as a modulated oscillator, with panel meter measuring filament voltage. Frequency of oscillations is adjusted with tuning dial, and is roughly as indicated by calibration.

1.4 Rectifier Wavemeter

The "Rectifier-Wavemeter" connection is so named because electrically the circuit is the same as for the instrument generally known by that name. However it is not intended that this connection in the Type A Test Set be used for measurement of wavelength (frequency). When the Type A is used with the Rectifier-Wavemeter connection, frequency calibration does not apply.

The Rectifier-Wavemeter connection is useful for neutralization of r-f amplifiers in transmitters, for audible observation of modulation in transmitters, and for other purposes.

Insert rectifier-wavemeter coil for desired frequency range, turn "ON-OFF" switch "ON", and "GRID-FIL" switch to "GRID". Test Set will then operate as a rectifier wavemeter, with panel meter measuring rectified r-f current. Resonant frequency of the coil is adjusted with tuning knob, and is not indicated by calibration on dial.

If the r-f current being investigated is modulated, this modulation may be heard by inserting pin tips of headphones cord into "PHONES" jack.

CAUTION: Initial tuning of the Test Set should be done with very loose coupling to the circuit carrying the r-f current being investigated. Then, if meter deflection is less than desired, coupling can be increased. Too much coupling during the initial adjustment may result in an overload to the panel meter. Also, if crystal phones are plugged into the "PHONES" jack, an excessive voltage will be applied to the headset if the coupling is sufficient to make the panel meter deflect off scale.

2.00 SPECIFIC APPLICATIONS FOR TYPE A TEST SET

2.01 Adjustment of Antenna and Matching-Section Lengths

Many antennas, such as some described in Sec.9.0,have resonant radiating portions and resonant matching sections. These lengths may be cut for resonance at a specific frequency by use of the Type A Test Set.

Put Test Set into operation as a grid-dip oscillator on the desired frequency range (See 1.2 Grid-dip Oscillator, above). Couple coil near a current loop in the resonant antenna or matching section; that is, near the center of a half-wave antenna, or near the shorting bar on a quarter-wave matching section. Tune Test Set dial, watching

meter for a sharp downward dip. When approximate dial setting for this dip has been found, loosen coupling until dip is just observable, and find exact dial setting for maximum dip. Note frequency indication of dial. This is the approximate resonant frequency of the element being measured.

If possible, the elements should be adjusted while installed in the locations and positions where they will be used. This is because proximity to ground or to walls of a room reduces the resonant frequency of the elements.

For information concerning use of Type A Test Set for adjustment of specific antennas, See Sec. C9.0, ANTENNAS, GENERAL. For adjustment of Type J Antenna, see Sec. C9.204, Type J Antenna Tuning, 30 Mc.

2.02 Neutralizing R-F Amplifiers in Transmitters

Several types of USFS Radiophones have neutralized final amplifiers. Service Data Sheets (See Sec. 13.0, SERVICE DATA SHEETS) for specific types give directions for determining whether neutralization is in need of adjustment, and in each case one or more methods of performing this adjustment are given. The method involving use of the Type A Test Set is convenient to use, and will be outlined here also.

Before starting any adjustment, make sure neutralization is in need of correction. Methods of determining whether this need exists are given in the Service Data Sheets.

Disconnect plate voltage from final (neutralized) stage. Turn on transmitter, and make all necessary adjustments so that proper excitation is provided for final stage. Put Test Set into operation as a rectifier wavemeter (See 1.4 Rectifier Wavemeter, above) on the desired frequency by coupling Test Set coil loosely to final-amplifier-grid coil, and tune Test Set dial for maximum meter deflection. If meter goes off scale, loosen coupling so that maximum meter reading will be on scale. Without disturbing this setting of the tuning dial, remove Test Set and couple its coil to the plate coil of the final amplifier. Adjust coupling so that Test Set meter shows some deflection. Using a fibre socket wrench or screwdriver, and leaving coupling between Test Set coil and final plate coil fixed, adjust neutralization for minimum deflection on Test Set meter.

At the conclusion of the neutralizing adjustment, test for correctness of neutralization by the method stated in the Service Data Sheets.

2.03 Test for Existence and Approximate Frequency of Oscillations in Transmitter or Receiver

The existence of oscillations may be detected with the Test Set used either as the rectifier wavemeter or as the grid-dip oscillator. Both methods are sensitive, and will detect oscillations from such sources as h-f oscillators in receivers and crystal oscillators in transmitters. Approximate frequency will be indicated only with the grid-dip oscillator arrangement.

To detect oscillations by use of the rectifier-wavemeter arrangement, put Test Set into operation as a rectifier wavemeter on the desired frequency range (See 1.4 Rectifier Wavemeter, above). Couple Test-Set coil to coil in circuit being investigated, or to a conductor which may be carrying r-f current. Tune Test Set dial, seeking an adjustment which produces a deflection on the meter. If the meter deflects, oscillations are present. Calibrations on tuning dial do not indicate frequency.

To detect oscillations by use of the grid-dip oscillator, put Test Set into operation as a grid-dip oscillator on the desired frequency range (See 1.2 Grid-dip Oscillator above). Couple Test Set coil to coil in circuit under investigation, or to a conductor which may be carrying r-f current. Tune Test Set dial, seeking an adjustment for which there is a sharp downward or upward deflection of the meter. Having found the approximate dial position for which this sharp deflection occurs, tune dial slowly past this point. If no oscillation is present, meter will simply dip downward as the dial is tuned through resonance with the circuit under test. However if oscillations are present, meter will dip downward, then will deflect sharply upward, then will again dip downward, after which it will resume a relatively steady reading. Dial must be turned vary slowly through resonance to observe this behavior.

Loosen coupling so that upward deflection is just observable. Note dial setting for maximum upward deflection. This is the approximate frequency of osciallations being studied.

2.04 Audible Check of Transmitter Modulation

Put Test Set into operation as a rectifier wavemeter for the desired frequency range (See 1.4 Rectifier Wavemeter, above), and insert pin tips of headphones cord into "PHONES" jack. Couple Test Set coil to transmitter output. This may be done by coupling Test Set coil loosely to final tank coil, or to antenna lead. An assistant should talk into the transmitter microphone while the technician turns the tuning dial, seeking an audible response in the headphones. The technician may judge quality of modulation from the reproduction in the headphones.

2.05 Measurement of Approximate Frequency of Tuned Circuits

The approximate resonant frequency of a tuned circuit may be measured with the same technique as outlined above for measurement of resonant frequency of antenna sections. Put Test Set into operation as grid-dip oscillator on desired frequency range (See 1.2 Grid-Dip Oscillator, above). Couple Test Set coil loosely to coil of circuit under examination, watching meter for a sharp downward dip. When the approximate dial setting for this dip has been found, loosen coupling until dip is just observable, and find exact dial setting for which dip is most pronounced. Note frequency indication on dial. This is the approximate resonant frequency of the tuned circuit being investigated.

2.06 Monitoring of Keying of C-W Transmitter

Put Test Set into operation as grid-dip oscillator for desired frequency range (See 1.2 Grid-Dip Oscillator, above) Insert pin tips of headphones cord in "PHONES" jack. Couple Test Set coil extremely loosely to transmitter output, or to antenna lead. Tune in signal with Test Set dial, and adjust dial setting for desired beat note. Coupling to transmitter must be sufficiently loose so there is but negligible tendency for the Test Set oscillator to "lock in" with the frequency of the transmitter. Key transmitter, making audible check on sharpness of characters.

3.0 TEST SET CIRCUITS

3.1 Grid-Dip Oscillators

When one of the oscillator coils is inserted, and the "GRID-FIL" switch is turned to "GRID", the Test Set functions as a tunable unmodulated oscillator. See Schematic Diagrams, Figs. 1 and 2. Frequency is adjusted with the tuning dial, and grid current is measured with the panel meter. In the Model AA (Serial numbers 4 and higher), the knob between the 2 switches controls plate voltage, and provides means of establishing grid-current indication on a useful part of the meter scale. This plate-dropping resistor eliminates the need for the fixed dropping resistor R-7 and associated bypass capacitor C-5, which were part of the high-frequency oscillator coil assembly in the Model A.

It is a characteristic of this type oscillator circuit that if a load is coupled into the tuned circuit of the oscillator, grid current will decrease. If an external tuned circuit is placed in inductive relation to the Test Set coil, the external circuit will couple load into the Test Set tuned circuit, provided the resonant frequencies of the two tuned circuits are approximately equal. Thus, if Test Set tuning knob is turned through resonance with the external circuit, load will be coupled into the Test Set circuit only while Test Set is near resonance with the external circuit. Under these conditions grid current, as indicated by panel meter, will "dip" as Test Set frequency is varied through resonance with the external circuit. This action is the source of the term "Grid-Dip Oscillator", and is the basis for the procedures described above (2.04 Adjustment of Antenna Length, and 2.05 Measurement of Approximate Frequency of Tuned Circuits) for measuring approximate resonant frequency of tuned circuits and antenna sections.

Details of the oscillator circuit may be learned from inspection of Schematic Diagrams, Figs. 1 and 2. With "GRID-FIL" switch in "GRID" position, d-c grid current flows through grid leak R-2 and the panel meter. R-3 is short-circuited by the circuit through the panel meter and the shorting-type twin-tip jack J-1.

3.2 Heterodyne Dectector

If the Test Set is put into operation as a grid-dip oscillator, and if pin-tips of a headphones cord are inserted in the "PHONES" jack, the resistance of R-4 in parallel with the headphones is inserted in series with the d-c grid circuit. Under these conditions the effective grid-leak resistance will be increased somewhat, being the sum of R-2 and the parallel combination of R-4 and the headphones. The oscillator will still oscillate smoothly with this increased grid-leak resistance.

If the oscillating pick-up coil is coupled to a source of r-f current, such as a radio transmitter, voltages of two separate frequencies may exist in the Test Set circuit. One of the frequencies will correspond

with the locally generated oscillations, while the other will correspond with the r-f current being picked up. Because of the rectifying action of the grid-filament portion of the tube, difference-frequency current will flow in the circuit through the headphones, and the beat-frequency tone will be heard, if it is within the audible frequency range. This type operation provides convenient means for observing transmitter keying, as noted above (2.06 Monitoring of Keying of C-W Transmitter).

Coupling between Test Set pick-up coil and transmitter must be extremely loose, or there will be a tendency for locally-generated oscillations to "lock in" with frequency of transmitter. Also, adequately loose coupling provides the possibility of adjusting tuning dial for a lower-pitched beat note before the "lock-in" effect occurs.

3.3 Modulated Oscillator

With one of the oscillator coils inserted, and with "GRID-FIL" switch turned to "FIL", the Test Set functions as a tunable oscillator, modulated at an audible frequency. With this connection, R-3 is switched in series with R-2, and R-3 becomes the effective grid leak, since R-3 has much higher resistance than R-2. When oscillations build up, d-c grid current also builds up. This d-c grid current flowing through the relatively high resistance of R-3 soon becomes sufficient to produce a large bias voltage on the grid of the tube. When this bias becomes sufficient to prevent the tube from oscillating, d-c grid current ceases, and bias decreases back to a small value. The tube is then again ready to start building up oscillations. This cycle of events repeats at an audio-frequency rate, and results in modulation of oscillations.

3.4 Rectifier Wavemeter

With one of the rectifier-wavemeter coils inserted, and with "GRID-FIL" switch turned to "GRID", the Test Set functions similarly to the instrument commonly known as a rectifier wavemeter. However, as noted above, it is not intended that this arrangement will be used to measure wavelength (frequency), and calibrations do not apply.

Referring to Schematic Diagrams, Figs. 1 and 2, the grid coil only is in the circuit, the plate coil being deleted from the rectifier-wavemeter coil assemblies. The grid coil and C-3 form the tuned pick-up circuit. Voltage induced in the grid coil is applied to the diode-rectifier circuit, including the panel meter and resistor R-2. When the Test Set tuned pick-up circuit resonates with the current in the external circuit, maximum voltage is applied to the rectifier circuit, and maximum current will be indicated on the panel meter.

If pin tips of a headphones cord are inserted in the "PHONES" jack, the parallel combination of R-4 and the headphones will be connected in series with the effective rectifier load resistance. If the signal being picked up is modulated, the rectifier action will produce modulation-frequency current through this load resistance. Thus audible reproduction of the modulation envelope will be heard in the headphones.

3.5 Changing a Tube in Model AA

If it becomes necessary to change a tube, the trimmer capacitor C-6 (in Model AA only) should be re-adjusted to compensate for the difference between inter-electrode capacitances of the old and new tubes. This should preferably be done with the Test Set operating as a grid-dip oscillator in the ultra-high frequency range. It is of course necessary to have an external r-f current of known frequency to make this adjustment. A Type T Model D Radiophone, or other crystal-controlled transmitter within the range of the ultra-high frequency oscillator coil is suitable.

Insert oscillator coil for ultra-high frequency range, and put Test Set into operation as a grid-dip oscillator. Couple Test Set coil loosely to transmitter. In the case of the Type T Model D Radiophone, the transmitter may be operated into a dummy load consisting of Two Mazda 44 or Mazda 46 lamps in series, connected between the 2 "ANT" posts. Test Set coil is coupled to the loop formed by the dummy load circuit between the "ANT" posts. If no dummy load is at hand, the Test Set coil may be coupled to the "Y" between the "ANT" posts and the 2-wire antenna transmission line. Set Test Set dial on the frequency of the transmitter. Adjust trimmer capacitor C-6 to resonance with the transmitter as indicated by upward deflection of panel meter. Loosen coupling until upward deflection is just observable, and re-adjust trimmer capacitance for maximum upward deflection of meter.

If no crystal-controlled ultra-high frequency transmitter or crystal-calibrated frequency meter is on hand, this adjustment may be made with a high-frequency crystal-controlled transmitter, such as a Type I, K, M, or SPF. Of course the oscillator coil for the high frequency range must be used under these conditions. The trimmer capacitance adjustment should be repeated with an ultra-high frequency crystal-controlled transmitter when one becomes available.

3.6 Batteries

The "A" battery consists of two flashlight cells. These are connected in series in the Model A, and in parallel in the Model AA. The "B" battery is a small 45-volt unit. For manufacturer's type numbers, see 4.0 Parts List.

In the Model A, filament voltage is indicated on the panel meter when "ON-OFF" switch is turned "ON" and "GRID-FIL" switch is turned to "FIL". Full scale reading is 4 volts. "A" battery should be replaced when it becomes necessary to turn filament rheostat all the way to the right to obtain a filament voltage of 2.1 volts.

In the Model AA, "A" battery voltage is indicated on the panel meter when "ON-OFF" switch is turned "ON" and "GRID-FIL" switch is turned to "FIL". Full-scale reading is 2 volts. "A" battery should be replaced when voltage falls to 1.1 volts, or sooner if oscillator grid current decreases.

"B" battery voltage should be measured with an external voltmeter. This measurement should be made with Test Set operating as a grid-dip oscillator. "B" battery should be replaced when voltage has dropped to 34 volts, or sooner if oscillator grid current decreases.

It is important that discharged batteries be removed from the Test Set cabinet. Old or discharged batteries may give off fluid or other products which have a highly corrosive effect upon metal parts. Also, this fluid will moisten considerable lengths of fabric wire covering by "wicking" action, and will permanently impair the insulating value of such covering.

4.0 PARTS LIST

4.1 Capacitors

Symbol	Component	Rating	Manufacturer	Type
C-1	Plate Blocking	.0005 Mfd Mica	(Solar (Aerovox	MW-1322 1465 *
C-2	Grid-Return Bypass	.002 Mfd Mica	(Solar (Aerovox	MW-1233 * 1467
C-3) C-4)	Tuning	50-50 Mmf Variable	Hammarlund	HFD-50
C-5	Grid Return Bypass (On Model A only)	.0005 Mfd Mica	(Solar (Aerovox	MO) * 1468)
C-6	Tuning Trimmer (In Model AA only)	30 MMF Variable Mica Compression Reduced	Hammarlund	MEX-30 Reduced by Cutting Lower Plate

4.2 Inductors

Symbol	Component	Description
L-1	Grid Coil, High Frequency Grid-Dip-Oscillator Assembly.	$43\frac{1}{4}$ turns #28 Enameled wire, Close-wound on top end of National XR-1 Form
L-2	Plate coil, High frequency Grid-Dip Oscillator Assembly.	$46\frac{1}{4}$ turns #28 Enameled wire, Close-would on pin end of same form with L-1. Equivalent of 1 turn Separation between L-1 and L-2.
L-3	Grid Coil, Ultra-High Frequency Grid-Dip-Oscillator Assembly.	$3\frac{1}{4}$ turns #20 Enameled wire, wound on top end of National XR-1 Form, Threaded 8 turns per inch.
L-4	Plate Coil, Untra-High Frequency Grid-Dip Oscillator Assembly	$3\frac{1}{4}$ turns #20 Enameled wire, wound on pin end of same form with L-3, threaded 8 turns per inch, $\frac{1}{4}$-turn gap between L-3 and L-4.
L-5	High-Frequency Rectifier-Wavemeter coil.	62 3-4 turns #28 enameled wire, Close-wound on National XR-1 Form.
L-6	Ultra-High Frequency Rectifier-Wavemeter coil.	4 3/4 turns #20 Enameled wire, wound on National XR-1 Form, threaded 8 turns per inch.

4.3 Resistors

Symbol	Component	Rating	Manufacturer	Type
R-1	Plate Filter	5000 Ohms 1/2 Watt	IRC	BT-1/2
R-2	Grid Return	5000 Ohms 1/2 Watt	IRC	BT-1/2
R-3	Grid Leak	1 Megohm 1/2 Watt	IRC	BT-1/2
R-4	Grid Return	25000 Ohms 1/2 Watt	IRC	BT-1/2
R-5	4-Volt Scale Multiplier	4000 Ohms 1/2 Watt	IRC	BT-1/2 only in Model A
R-6	Filament Rheostat	20 Ohms Variable	Mallory	C-20-R only in Model A
R-7	Plate Filter	15000 Ohms 1/2 Watt	IRC	BT-1/2 only in Model A
R-8	Plate Dropping	50000 Ohms Variable	Mallory	MR-34 only in Model AA
R-9	2-Volt Scale Multiplier	2000 Ohms 1/2 Watt	IRC	BT-1/2 only in Model AA

4.4 Tubes

Symbol	Component	Manufacturer		Type
VT-1	Oscillator-Rectifier	Sylvania	30	(Only in Model A)
VT-1	Oscillator-Rectified	Sylvania	1E4G ~~1H4G~~	(only in Model AA)

4.5 Switches

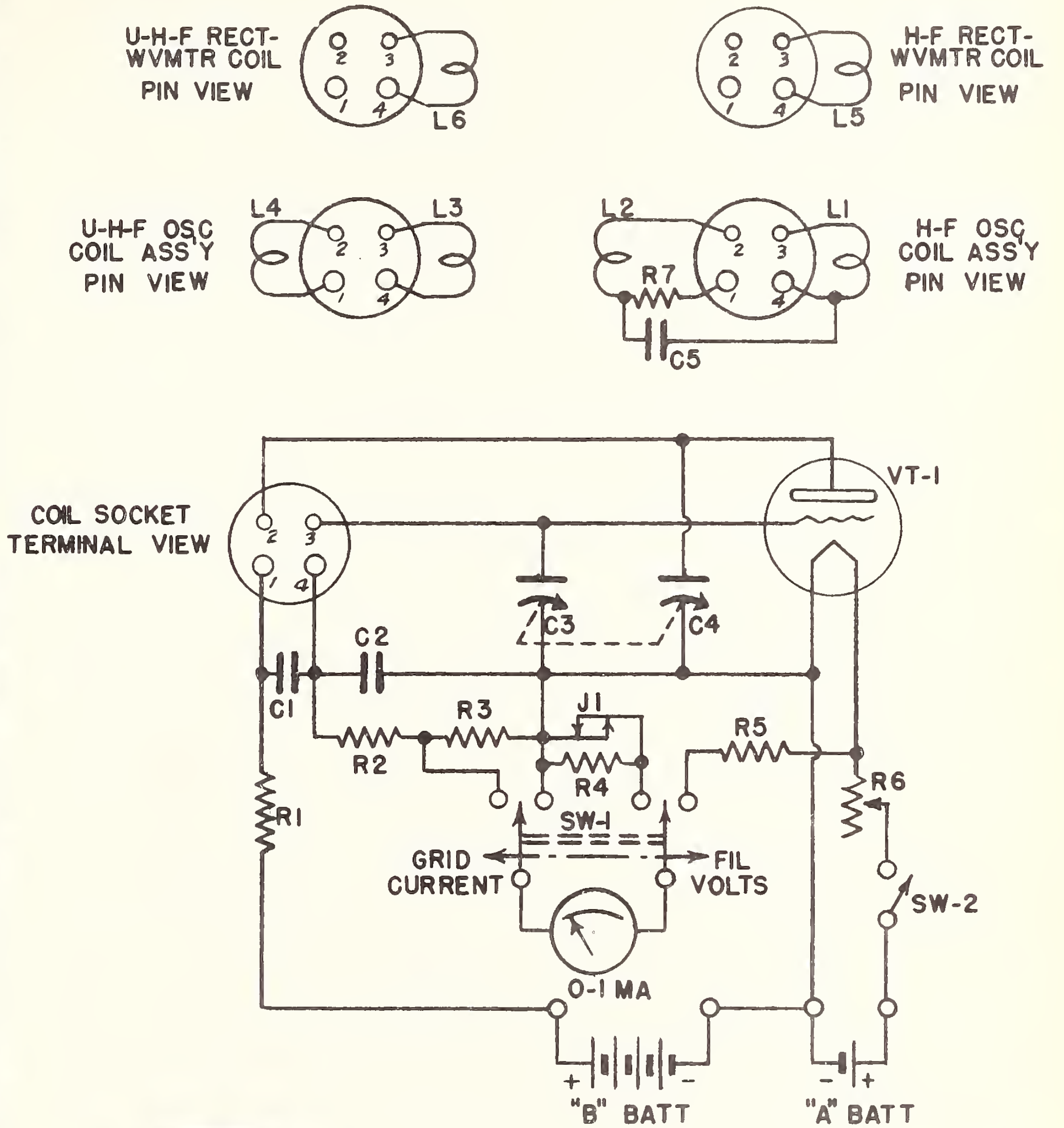
Symbol	Component	Manufacturer	Type
SW-1	Grid-Filament	H & H	DPDT, Nickel-plated Short-Shank, Toggle
SW-2	ON-OFF	H & H	SPST, Nickel-Plated Short-Shank Toggle

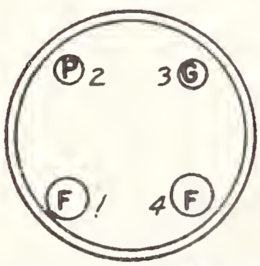
4.6 Batteries

Quantity	Use	Manufacturer	Type
2	"A"	Eveready Burgess General	950 No. 2 D
1	"B"	Burgess	X-30-BP

4.7 Miscellaneous

Component	Manufacturer	Type	
Milliammeter, 0-1 MA D.C.	(Simpson (Triplett	127) 227)	
Dial	National	BM-1	
Socket,4-Prong, for Coil Receptacle	Amphenol	RSS4	
Socket,4-prong, Tube (Only in Model A)	Amphenol	RSS4	
Socket,8-Prong, Tube (only in Model AA)	Amphenol	RSS8	
Knob (only in Model AA)	Bud	750	
Cabinet	Globe-Wernecke	85-C	Oak File Case





SOCKET CONNECTIONS
TYPE 30
BOTTOM VIEW

FIG. 1

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE A TEST SET

MODEL A

DRAWN BY E.H.S. CHECKED BY H.K.L.

SEPT. 28, 1939

Radio Hdbk
Added 10-16-39, No. 1

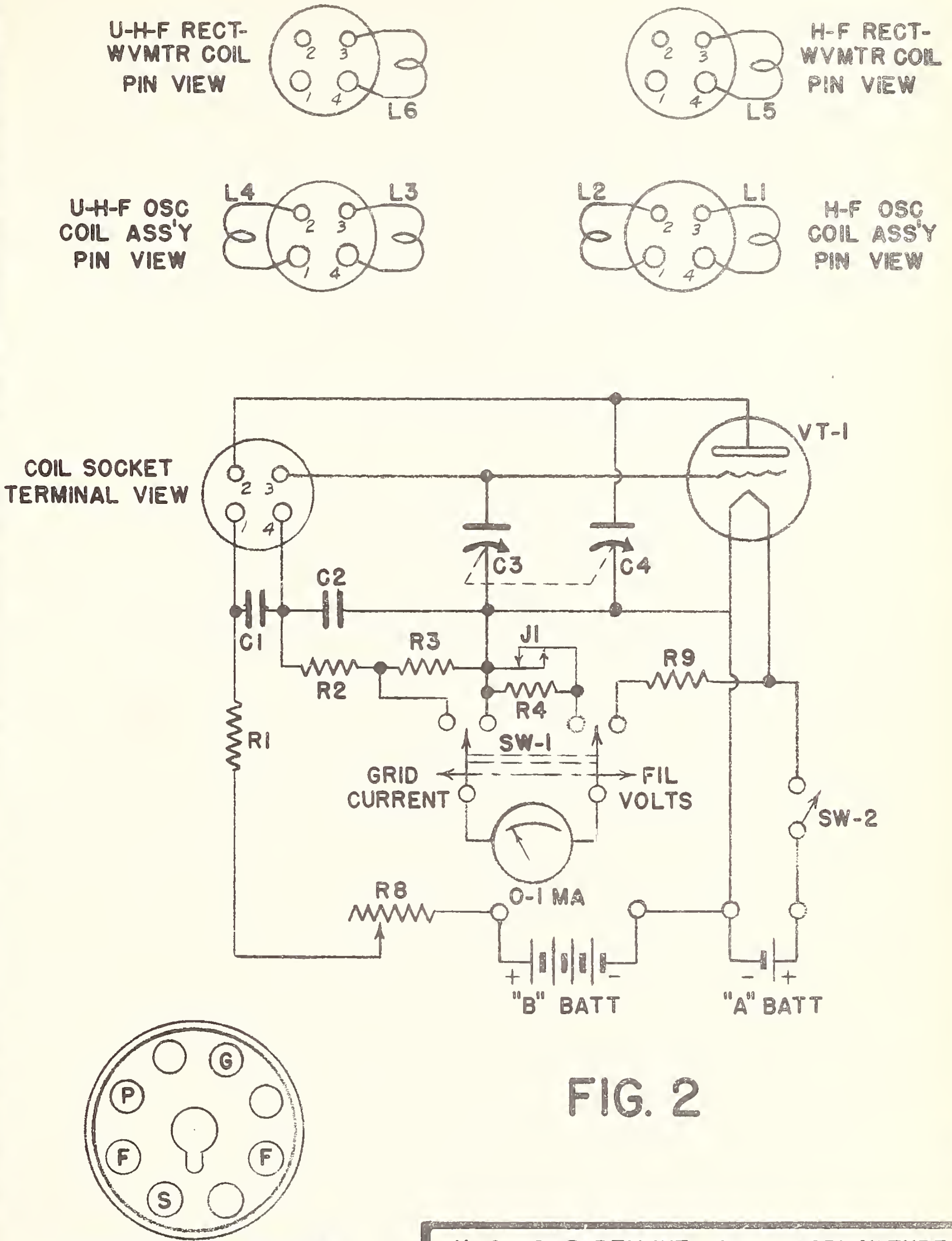


FIG. 2

SOCKET CONNECTIONS
TYPE ~~1H4G~~ 1E4G
BOTTOM VIEW

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE A TEST SET

MODEL AA

DRAWN BY E.H.S. CHECKED BY H.K.L.

SEPT. 29, 1939

C12.301 Type A Test Set

Models AB and B

Model AB Nos. 14 to 16 Inc.

Model B Nos. 17 to Inc.

Model - B

Radio Hdbk.
Added 6-10 41
No. 9

The Type A test set, models AB and B, is similar to the model AA. Minor changes result in improved ease of operation.

Only one coil is provided for each frequency range, instead of the 2 in the model AA. Selection of oscillator operation or rectifier-wavemeter operation is made by the switch coupled to the plate-rheostat knob, instead of by changing coils. Frequency limits for the 2 ranges are slightly different from those in the model AA, and are tabulated below. A phone-plug jack is furnished in addition to the phone-tip jacks. Battery arrangement is identical with that in the model AA. A type 1LE3 tube is used in models AB and B.

Table 1
Frequency Ranges

	High-Frequency Coil	Ultra-High-Frequency Coil
Model AB	2.7 - 5.0 Mc	25 - 46 Mc
Model B	2.6 - 3.6	30 - 42

While the procedure for use of the instrument is substantially as described for the model AA, the following difference should be noted:

To set the instrument in operation as a rectifier-wavemeter, proceed as outlined in Item 1.2, then turn the knob between the 2 switches all the way to the left (until a click is heard). Test set will then operate as a rectifier-wavemeter, with panel meter indicating rectified r-f current, and tuning dial calibrations indicating approximate resonant frequency.

On replacing a coil in the cabinet cover, the coil should be inserted with the frequency-range figures, or with the paint mark up. This will insure that the clip will not rub against coil leads on the inside of the coil form.

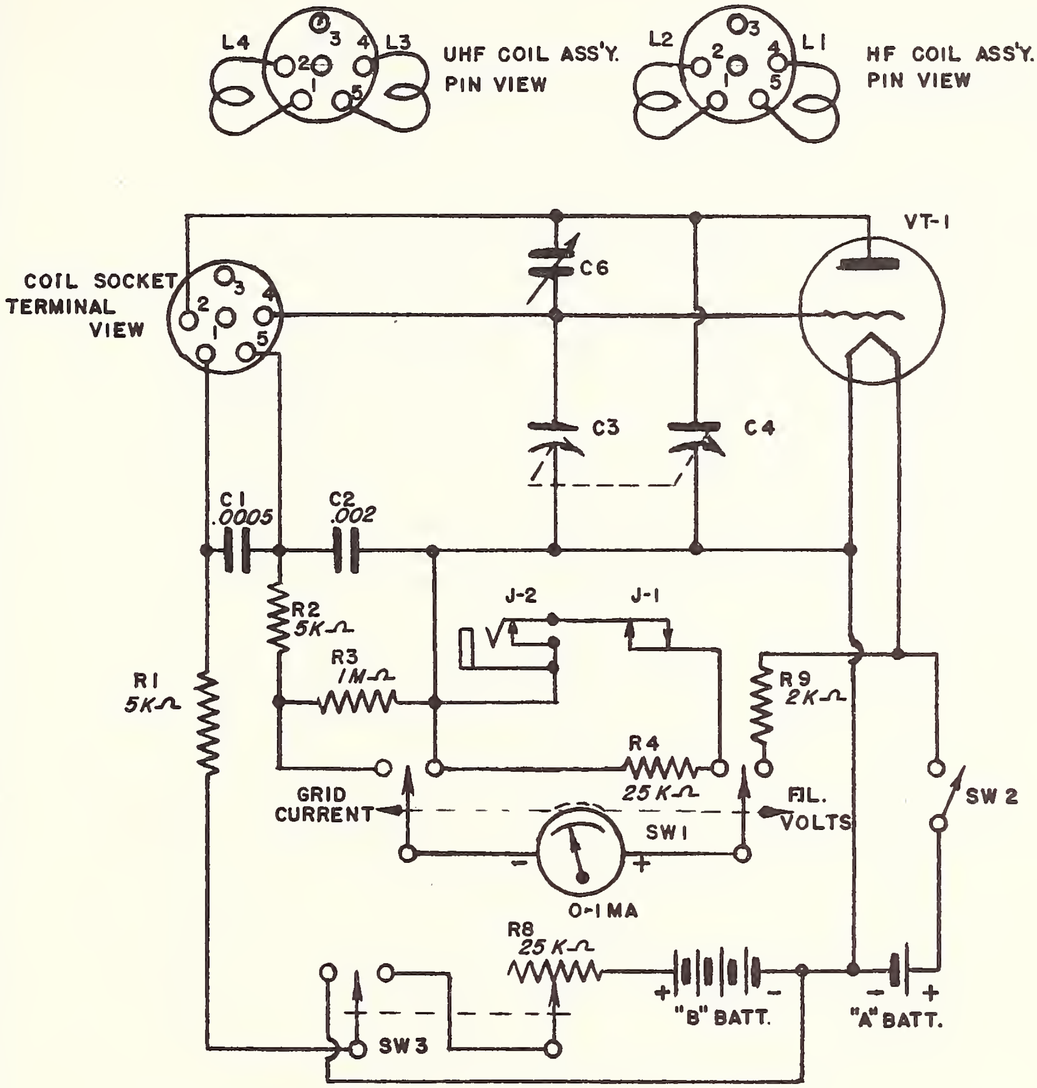
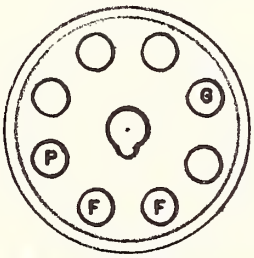


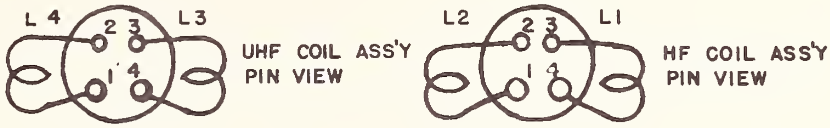
FIG. 3.



SOCKET CONNECTIONS
TYPE 1LE3
BOTTOM VIEW

U. S. DEPARTMENT OF AGRICULTURE FOREST SERVICE TYPE A TEST SET MODEL AB	
DRAWN BY G.B.C. CHECKED BY E.H.S. DATE APR. 30, 1941	USFS RADIO LAB DRWG A-AB-21-A

FORM RL-1



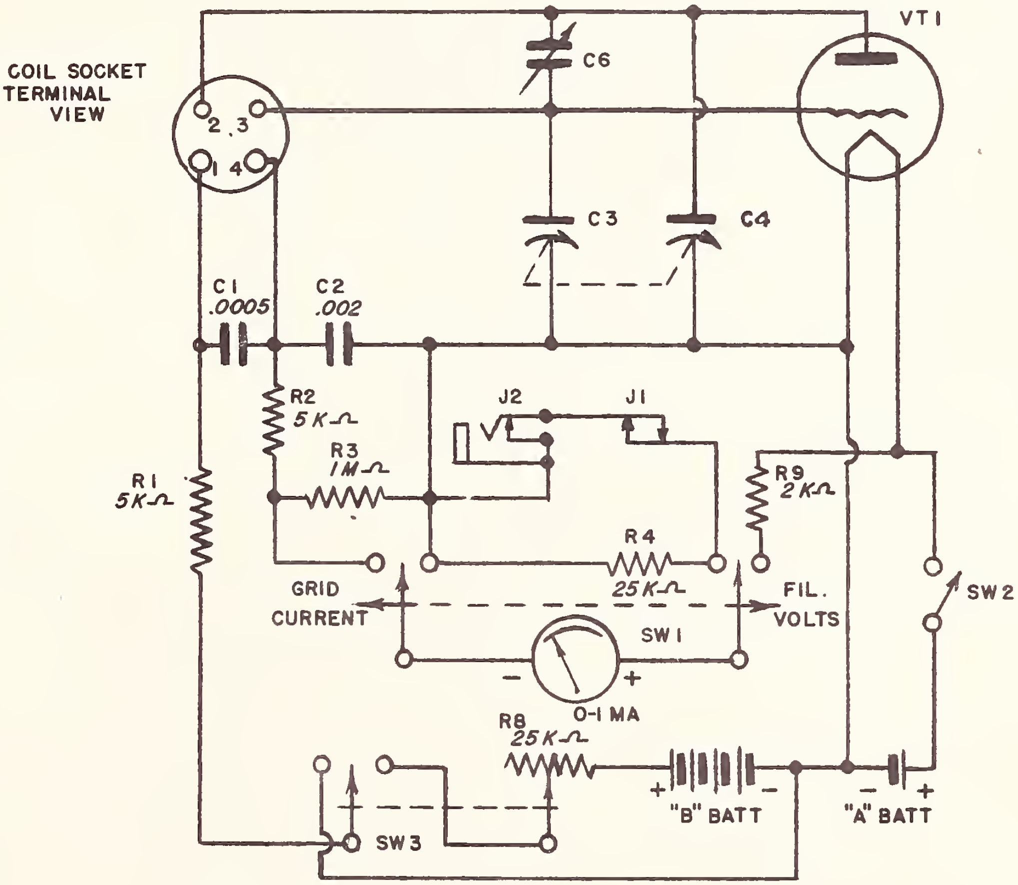
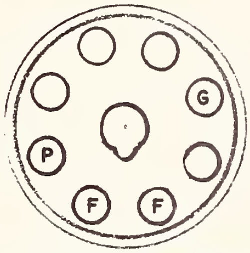


FIG. 4.



SOCKET CONNECTIONS
TYPE ILE 3
BOTTOM VIEW

U. S. DEPARTMENT OF AGRICULTURE FOREST SERVICE TYPE A TEST SET MODEL B	
DRAWN BY G.B.C. CHECKED BY E.H.S. DATE APR. 30, 1941	USFS RADIO LAB DRWG A- B -21-A

C12.302 Type D Test Set

Instructions for Operating
Miscellaneous Notes

Model_______Nos.________to_______Inc.

Model_______Nos.________to_______Inc.

Model_______Nos.________to_______Inc.

Model_______Nos.________to_______Inc.

Model_______Nos.________to_______Inc.

Radio Hdbk
Added 10-16-39
No. 1

0.0 General Description

The Type D Test Set, Model A, supplies a frequency-modulated test signal for use in visual alignment of wide-band i-f amplifiers. A suitable oscilloscope is also necessary for the alignment operation.

With the coil and crystals supplied, the instrument is applicable to the alignment of a 4050-kc amplifier, with a pass band width up to 50 kc, such as the i-f amplifier in the Type T radiophone, Model D. To align i-f amplifiers of another frequency, a special coil is required, as well as an additional pair of "marker" crystals of proper frequency.

The instrument is well shielded and is furnished with an output attenuator. Frequency modulation of the oscillator is accomplished by means of a vibrating capacitor shunting the tuning capacitor. The vibrating capacitor is driven by a modified telephone bell ringer. Two crystal oscillators using Pierce circuits provide "marker" frequencies to establish the frequency limits of the pass band on the oscilloscope trace.

Weight of the Type D Test Set is approximately 10 lbs. Dimensions are 10" wide x 6-1/4" high x 8" deep. The device operates only from a 115-volt 60-cycle a-c power source.

Instructions for use are outlined in Sec. C13.7, "Type T Radiophone, Model D", Item 2.2, "Receiver Data".

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Output cord blocking	.001 mfd mica	Aerovox	1465
C2	Frequency modulator	Special		
C3	F-M oscillator tuning	35 mmf variable	Hammarlund	HF-35
C4	F-M oscillator grid	.0001 mfd mica	(Aerovox (Solar	1466) MT-1316)
C5	F-M oscillator output coupling	.0001 mfd mica	(Aerovox (Solar	1466) MT-1316)
C6	F-M oscillator screen bypass	.1 mfd 400-V paper	Solar	MP-4147
C7	High-Freq-Marker oscillator coupling	30 mmf mica compression variable	Mallory	CT-959
C8	High-Freq-Marker oscillator grid	.000025 mfd mica	(Aerovox (Solar	1468) MO-1406)
C9	Low-Freq-Marker oscillator coupling	30 mmf mica compression variable	Mallory	CT-959
C10	Low-Freq-Marker oscillator grid	.000025 mfd mica	(Aerovox (Solar	1468) MO-1406)
C201	Power line filter	.1 mfd 400-V paper	Solar	MP-4147
C202	Power line filter	.1 mfd 400-V paper	Solar	MP-4147
C203	Power supply filter	8. mfd 450-WV electrolytic)	Solar	M-488
C204	Power supply filter	8. mfd 450-WV electrolytic)	Solar	M-488
C205	Power supply filter	.1 mfd 400-V paper	Solar	MP-4147

2.52 Inductors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L1	4050 kc oscillator	57 turns #24 enameled wire, tapped at 14 turns, wound on Amphenol Type 24-4P form.		
L2	1600-kc oscillator	#32 DSC wire, wound in 4 sections on ceramic form from Hammarlund Type CH-8 choke. Coils are wound for proper inductance, according to following table:		

Coil Section	Inductance
Pin #3 to Pin #2	55 microhenries
Pin #3 to Pin #4	310 "
Pin #3 to Pin #1	620 "

Coil and ceramic form are mounted inside National Type XR-1 coil form.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L3		Winding on vibrating mechanism for C2.		
L201	Power supply filter choke	10 henries, 40 ma	Thordarson	T-13C27
RFC201	Power line filter		Ohmite	Z-1
RFC202	Power line filter		Ohmite	Z-1

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R1	F-M oscillator grid leak	0.1 megohm, 1/2 watt	IRC	BT-1/2
R2	F-M oscillator screen voltage divider	10000 ohms, 1 watt	IRC	BT-1
R3	F-M oscillator screen voltage divider	10000 ohms, 2 "	IRC	BT-2
R4	F-M oscillator plate	2000 " 1/2 "	IRC	BT-1/2
R5	High-Freq-Marker oscillator output voltage divider	2000 " 1/2 "	IRC	BT-1/2

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R6	High-Freq-Marker oscillator grid leak	0.1 megohm, 1/2 watt	IRC	BT-1/2
R7	High-Freq-Marker oscillator output voltage divider	0.1 megohm, 1/2 watt	IRC	BT-1/2
R8	Low-Freq-Marker oscillator output voltage divider	2000 ohms, 1/2 watt	IRC	BT-1/2
R9	Low-Freq-Marker oscillator output voltage divider	0.1 megohm, 1/2 "	IRC	BT-1/2
R10	Low-Freq-Marker oscillator grid leak	0.1 megohm, 1/2 "	IRC	BT-1/2
R11	Attenuator	5000 ohms, 1/2 "	IRC	BT-1/2
R12	"Attenuator Vernier" control	500 ohms linear variable	Centralab	72-118
R13	Attenuator	1000 ohms, 1/2 watt	IRC	BT-1/2
R14	Attenuator	1000 " 1/2 "	IRC	BT-1/2
R15	Attenuator	100 " 1/2 "	IRC	BT-1/2
R16	Attenuator	100 " 1/2 "	IRC	BT-1/2
R201	"Freq Swing" control	5000 ohms linear variable	Centralab	72-110
R202	Vibrating-mechanism-coil voltage dropping	12500 ohms, 2 watt	IRC	BT-2
R203	Plate supply filter	500 " 1 "	IRC	BT-1

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT1	F-M oscillator	Sylvania	7B7
VT2	High-Freq-Marker oscillator	Sylvania	7A4
VT3	Low-Freq-Marker oscillator	Sylvania	7A4
VT4	Rectifier	Sylvania	7Y4

2.55 Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T201	Power transformer	Thordarson	T-13R19

2.56 Switches

SYMBOL	COMPONENT	MANUFACTURER	TYPE
SW1	High-Freq-Marker oscillator on-off	H & H	SPST, small toggle with short nickel-plated shank
SW2	Low-Freq-Marker oscillator on-off	H & H	SPST, small toggle with short nickel-plated shank
SW3	Attenuator	Mallory	3223J
SW201	A-C power on-off	H & H	SPST, small toggle with short nickel-plated shank
SW202	Plate voltage on-off	H & H	SPST, small toggle with short nickel-plated shank

2.59 Miscellaneous

QUANTITY	COMPONENT	MANUFACTURER	TYPE
1	Crystal, 4075-kc, with holder, for high-freq-marker oscillator	Radio Specialty	B
1	Crystal, 4025-kc, with holder, for low-freq-marker oscillator	Radio Specialty	B
	(Additional pairs of crystals may be needed to align wide-band i-f amplifiers with band-center frequencies other than 4050 kc).		
1	Vibrating mechanism for C2	Automatic Electric	D-56334-A Harmonic Ringer, 66.6 cycles, Cat. No. A5-39 (Note 1)
1	Socket, 4-prong	Amphenol	RSS-4
2	Sockets, 5-prong	Cinch	Y-16
3	Sockets, 8-prong	Amphenol	88-8
1	Socket, 8-prong	Amphenol	88-8T
1	Cord, power, with male plug	Belden	1725
1	Shield, oscillator coil	Bud	SH-278
1	Lamp, pilot	Sylvania	S-44
1	Socket, pilot lamp	ARHCo	1539
1	Cap, pilot lamp	Western Electric	4F
1	Cord, output, concentric, 22 inches	Bassett	BCF-64-200
2	Assemblies, plug and socket, for output cord	ARHCo	221
1	Clip, output cord ground	Mueller	45-C
1	Clip, output cord	Mueller	88
4	Knobs	Mallory	366
1	Dial, for "Freq" knob	Crowe	550
1	Dial, for "Attenuator Vernier" knob	Crowe	551

Note 1: Movable plates of C2 are mounted on bell-clapper rod, and vibrating assembly is adjusted to mechanical resonance with 60 cycles.

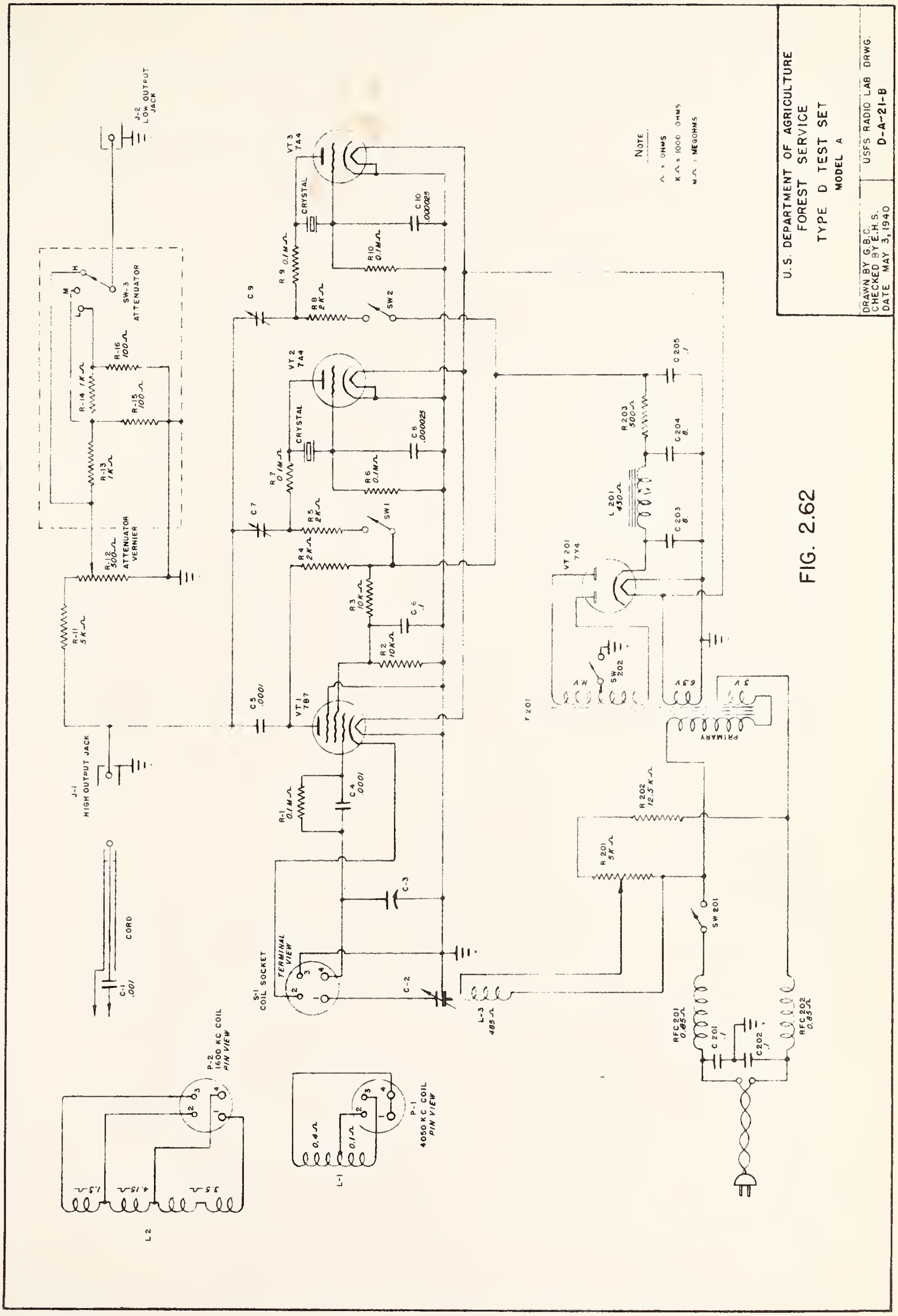

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE D TEST SET
MODEL A
DRAWN BY G.B.C.
CHECKED BY E.H.S.
DATE MAY 3, 1940
USFS RADIO LAB DRWG.
D-A-21-B
NOTE
KΩ = 1000 OHMS
MΩ = MEGOHMS
J-2 LOW OUTPUT JACK
SW-3 ATTENUATOR
R-16 100Ω
R-14 1KΩ
R-15 100Ω
R-13 1KΩ
R-12 500Ω ATTENUATOR VERNIER
R-11 5KΩ
J-1 HIGH OUTPUT JACK
CORD
C-1 .001
VT 3 7A4
CRYSTAL
C 10 .000025
R 9 0.1MΩ
R 10 0.1MΩ
C 9
R 8 2KΩ
SW 2
VT 2 7A4
CRYSTAL
C 8 .000025
R 7 0.1MΩ
R 6 0.1MΩ
C 7
R 5 2KΩ
SW 1
R 4 2KΩ
R 3 10KΩ
C 6 .1
R 2 10KΩ
C 5 .0001
VT 1 7B7
R-1 0.1MΩ
C 4 .0001
C-3
S-1 COIL SOCKET TERMINAL VIEW
C-2
L-3 485Ω
C 205 .1
R 203 500Ω
C 204 8
L 201 450Ω
C 203 8
VT 201 7Y4
SW 202
HV
6.3V
5V
PRIMARY
T 201
R 202 12.5KΩ
R 201 5KΩ
SW 201
RFC 201 0.85Ω
C 201 .1
C 202 .1
RFC 202 0.85Ω
P-2 1600 KC COIL PIN VIEW
P-1 4050 KC COIL PIN VIEW
L-1
0.4Ω
0.1Ω
L2
1.5Ω
4.15Ω
3.5Ω

FIG. 2.62

C12.303 Type 245-R Battery Tester

Instructions for Use

CONTENTS

		Page
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1.0	Application	2
2.0	Testing Batteries	3
2.1	Interpreting the Readings	3
2.2	Estimating Useful Life Remaining in Used Batteries	4

0.0 General Description

The type 245-R battery tester is a multi-range d-c voltmeter, with provision for taking load current from a dry battery while a voltage measurement is taken. With the load switch turned to "LOAD ON", battery drains are approximately as listed in Table 1.

TABLE 1
Battery Load Currents

Meter Full Scale	Nominal Battery Voltage	Current Drain at Nominal Battery Voltage
0-2 volts	1.5 volts	750 ma
0-4	3.0	750
0-8	7.5	75
0-8	4.5	45
0-50	45	45
0-100	90	45
0-150	135	45
0-150	144	48

With load switch burned to "LOAD OFF", meter resistance is 1000 ohms per volt.

1.0 Application

If a high resistance voltmeter is used and no load current is taken from the battery, a voltmeter indication of normal voltage is not necessarily proof that the battery is in good condition. The type 245-R battery tester, with its provision for draining the proper load current from the battery while it indicates voltage, constitutes an adequate means for checking the serviceability of the battery.

Probably the most important occasions for checking radio batteries arise when the batteries are sent out for field use, either as part of a radiophone or for replacement in a radiophone which may be operating in the field. Although a battery may be new and in its original carton, experience has shown that a certain percentage of stored batteries deteriorate even during brief storage periods. This is especially true of the smaller "B" batteries. The deterioration is more likely to occur under hot, dry storage conditions. For the case of radiophones returned from a tour of field duty, there is usually uncertainty concerning the amount of use batteries have had, and whether they should be replaced before sending the radiophone into the field again.

It may be desirable to test new batteries upon receipt of an order from a supplier.

2.0 Testing Batteries

CAUTION: The full-scale meter range selected must correspond with the value listed in Table 1 for the rated voltage of the battery under test. If an incorrect full-scale range is selected, which is lower than the rated battery voltage, the meter may be damaged.

It is important that all battery measurements be made with the load switch in "LOAD ON" position. It is preferable to test "B" batteries singly, rather than to test several series-connected batteries as a unit. However, a group test is satisfactory for the 4 series-parallel-connected #6 cells used for the "A" battery in the Type SPF, and in the Type T, Model D.

In measuring battery voltage, hold meter prods on battery terminals for 5 or 10 seconds. Read the voltage, and note whether the needle indicates a steady value, or a gradually decreasing amount. If a gradually decreasing amount is indicated, continue to hold prods on terminals as long as decrease continues. Usually under these conditions voltage will decrease below the low limit established for the battery, in which case it should be rejected.

2.1 Interpreting the Readings

New batteries normally exhibit almost full rated voltage. Batteries with larger cells show least departure from rated voltage. Table 2 lists voltages indicated for fresh batteries of various types.

Table 2
Voltages for Fresh Batteries

Battery Type	Use	Voltage Under Load
#6 Cell	"A"	1.45
4H2, 2F2H, X-248, 723	"A"	2.8
21308, V-30-FL, V-30-H, 386	Heavy-duty "B"	45
V-30-B, 5308, 762, 762-S	"B"	45
V-30-AA-2, Z-30-N	Portable "B"	43
P-96-AA, Z-96-P	Portable "B"	137
H-3-AF, A-3-BP, A-3-BPX	$4\frac{1}{2}$-volt "C"	4.4
V-5-PW, W-5-BP	$7\frac{1}{2}$-volt "C"	7.2

2.2 Estimating Useful Life Remaining in Used Batteries

Battery terminal voltage gradually decreases with use, finally reaching a low limit called the "end point", below which the battery is considered unfit for further service. End points for commonly used batteries are listed in Table 3. Although the rate of voltage decrease is not uniform, an estimate of remaining battery life based on the assumption that it is uniform will be sufficiently close for practical purposes, and the small error will be on the safe side. For a good approximation, the remaining battery life can be estimated by comparing the battery terminal voltage (under load) with the initial voltage and the end point voltage. For example, if the observed terminal voltage is midway between the initial voltage and the end point voltage, we may assume that about one-half the useful battery life remains.

Table 3
Battery End Points

Type Battery	End-Point Voltage
45-volt "B"	34 volts
144-volt "B"	110
3-volt "A"	2.2
1.5-volt "A"	1.1

C12.400 SERVICING AIDS AND DEVICES

Radio Hdbk
Added 10-16-39
No. 1

C12.401 Coupling Network for Introducing Signal into Radio Receiver

Radio Hdbk
Added 10-16-39
No. 1

C12.401 Coupling Network for Introducing Signal into Radio Receiver

In the servicing of radio receivers, especially those of the superheterodyne type such as Types I, M, SPF, and Type T Model D, it is frequently necessary to apply an artificial signal from a signal generator to the grid of one of the r-f or i-f amplifier tubes. Certain precautions are necessary.

Signal from the signal generator must be applied to the grid in series with a blocking capacitor, so that the grid bias developed in the receiver will not be affected by a d-c circuit from grid to ground through the attenuator in the generator. This capacitor need be only large enough so that its reactance is small compared with the high input resistance of the tube. For r-f and i-f amplifiers, a .0005 mfd. mica capacitor is suitable.

A high resistance should be inserted between the grid and what is normally the grid end of the input circuit. This resistor provides a circuit by means of which grid bias is applied to the tube under test. At the same time it prevents the tuned input circuit from having an appreciable shunting effect on the grid, for signal-frequency voltage. A 0.5-megohm 1/2-watt resistor is suitable.

The assembly suggested in Fig. 1 is applicable where it is desired to introduce signal to a tube whose grid connection terminates in a grid cap. One lead from the blocking capacitor and one lead from the resistor are soldered to a grid clip. The free end of the resistor is terminated in a metal cylinder the same size as the grid cap on the tube. To make use of this assembly, the radio-receiver grid clip is removed from the tube in which it is desired to introduce signal, and the grid clip of the assembly of Fig. 1 is placed in its stead on the grid cap. The radio-receiver grid clip is then placed on the free end of the resistor. Ungrounded wire of signal-generator cord is conveniently connected to the free end of the capacitor by means of a small alligator or battery clip which may be attached to the cord terminal.

The small metal cylinder which is soldered to the free end of the resistor may be the grid cap from a discarded tube, or one of the terminals of an automobile-type fuse.

The assembly of Fig. 1 provides a rapid means of introducing signal to various points in the receiver. Long leads and uncertain connections are avoided.

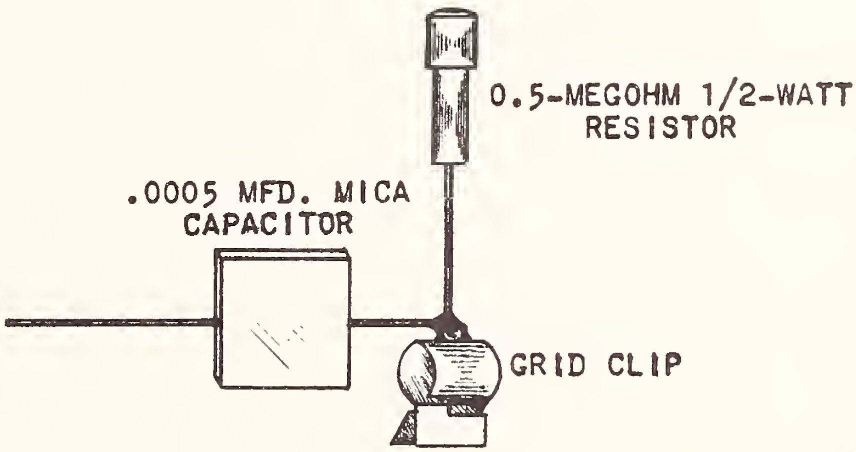

FIG. 1 COUPLING NETWORK FOR INTRODUCING SIGNAL INTO RADIO RECEIVER

C12.402 Radio Frequency Pick-up Device for Oscilloscope

Radio Hdbk
Added 10-16-39
No. 1

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1.2	32-39 Mc Band	5
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2.2	References	11

C12.402 R-F Pick-Up Device for Oscilloscope

0.0 General Description

The device described in this Section, when used for supplementing a suitable oscilloscope, permits visual observation of the modulation envelope on the signal at a radio transmitter. The method is applicable to Forest Service radiophones operating in the 3000-3500 kc range. Where the input capacitance of the oscilloscope is not too high, the method can also be used for radiophones in the 32-39 Mc range.

0.1 Circuit Discussion

Broadly speaking, the method for reproducing the modulation envelope of the transmitter signal is as follows: A small amount of energy is extracted from the transmitter output circuit by inductive coupling. The voltage in the pick-up loop is stepped up sufficiently so that a conveniently-observed amplitude is produced on the oscilloscope screen. The frequency of the sweep oscillator within the oscilloscope is adjusted to an appropriate sub-multiple of the modulation frequency, so that a few cycles of modulation-frequency wave appear on the screen.

The resulting image then shows a luminous area bounded on top and bottom by the modulation envelope. A typical image is shown in Fig. 6. Of course individual r-f cycles will not be evident, because the sweep frequency is too low and is not synchronized with the radio frequency.

It is assumed that the technician has familiarized himself thoroughly with the contents of the instruction book furnished by the manufacturer of his cathode-ray oscilloscope, and that he understands the function and use of each control knob on the instrument. For further information the technician may consult the references listed in 2.2 "References".

The sensitivity of tubes used in usual cathode-ray oscilloscopes may be between 35 and 75 peak volts per inch; that is, the spot on the screen will deflect one inch for an applied voltage of between 35 and 75 peak volts. Since this sensitivity is insufficient for many purposes, nearly all commercial oscilloscopes have an internal amplifier which may be switched in between the input terminals and the actual vertical-deflection-plate terminals on the cathode-ray-tube socket. While this amplifier has a wide frequency response for audio frequencies, it does not operate effectively at radio frequencies, and is therefore not useful for amplifying a modulated r-f voltage. Thus the internal amplifier must be switched out of the circuit, and some external means provided for increasing the voltage picked up from the transmitter. This Section describes the external device which accomplishes the desired voltage increase.

Use is made of the impedance-transforming properties of a tuned circuit. Fig. 1 shows a coil shunted by a variable capacitor. The r-f impedance measured across the coil will, in general, be high. With a good coil this impedance may be between one-half and one megohm. It is well known that if terminals are provided across a portion of the coil, such as terminals B and C, the impedance measured between these terminals will be lower than across the entire coil. The smaller the portion of the coil included between B and C, the lower will be the impedance at these terminals. Thus a power source of low impedance may be connected to terminals B and C to supply a high-impedance load connected to terminals A and C. This impedance transformation is accompanied by a voltage transformation. Thus, if a low-voltage source of relatively low impedance is connected to terminals B and C, a higher voltage will be produced at terminals A and C. The low-voltage low-impedance source may be the pick-up loop which is placed in inductive relation to the transmitter, and the high-impedance load across which the transformed high voltage is applied may be the vertical-deflection plates of the oscilloscope.

Variations are possible in the details of coupling the pick-up loop to the tuned circuit. Thus Fig. 2 shows an arrangement using link coupling. In Fig. 3 the pick-up loop is connected in series with the coil and capacitor.

1.0 Constructional Features

1.1 3000-3500 kc Band

While any of the circuits of Figs. 1, 2, or 3 may be used with equal success, details given here apply to the arrangement of Fig. 3. Capacitor C-1 and coil L-1 may be mounted on a small base board and panel. It is suggested that L-1 be wound on a plug-in coil form, so that other frequency ranges may be provided if needed.

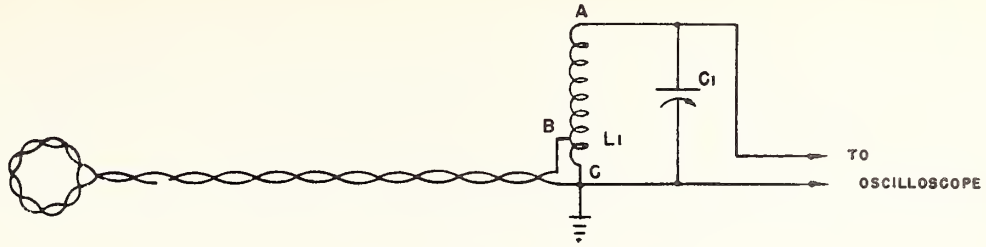

FIG. 1.

CIRCUIT WITH TAPPED-COIL COUPLING.

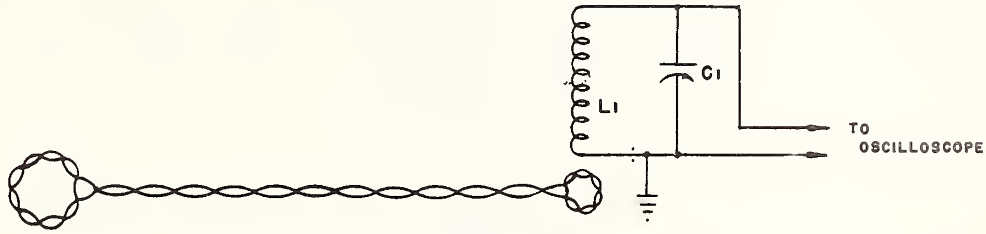

FIG 2
CIRCUIT WITH INDUCTIVE COUPLING.

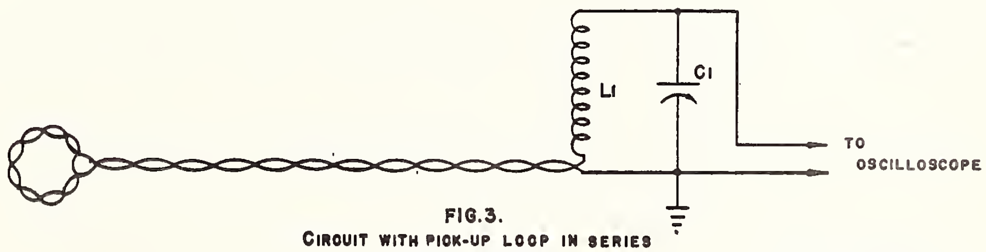

FIG. 3.
CIRCUIT WITH PICK-UP LOOP IN SERIES WITH TUNED CIRCUIT.

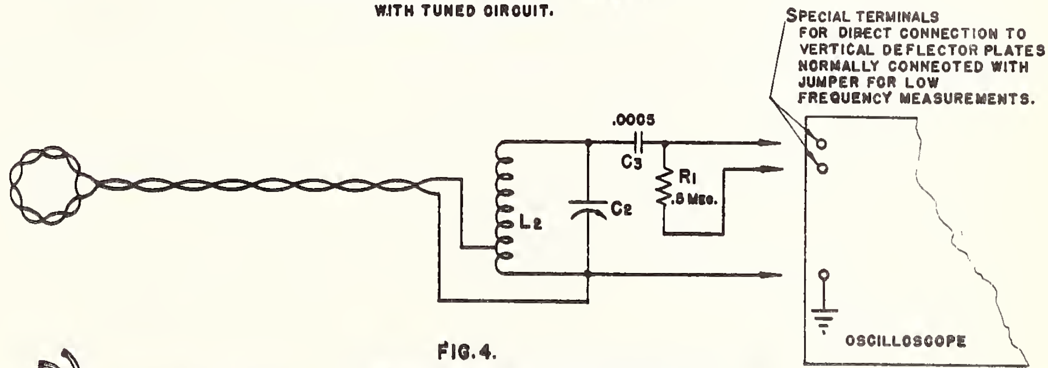

FIG. 4.

CIRCUIT FOR USE WITH OSCILLOSCOPE HAVING SHORT DIRECT CONNECTIONS TO VERTICAL DEFLECTION PLATES.

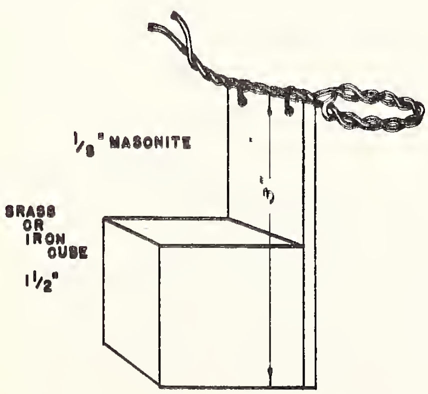

FIG. 5.
MECHANICAL SUPPORT FOR PICK-UP LOOP.

U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPICAL CIRCUITS
R-F PICKUP DEVICE FOR OSCILLOSCOPE

DRAWN BY G.B.C. CHECKED BY E.H.S. DATE APR. 9, 1940	USFS RADIO LAB DRWG SI-0-21-B

FORM RL-3

The pick-up loop and leads may be made of loop antenna wire. The loop diameter should be about 1" or $1\frac{1}{4}$". The two turns of the loop and the two lead wires from the loop should be twisted together, as shown diagrammatically in Fig. 3. A length of about 3 feet will be found convenient for the twisted pair. The twisted-pair terminals may be anchored to a 2-terminal tie point mounted to the base board. To make a workmanlike connection with loop antenna wire, the insulation should be removed about 1/4-inch from the end. A tightly-wound single-layer wrap of about #30 bare wire, tinned if available, should be started over the insulation about 1/16th inch from the end of the insulation. This wrap should extend over the last 1/16th inch of insulation and continue around the bare end of the lead. The wrap is then sweated with solder. A substantial terminal to which to solder is thus provided.

The pick-up loop may be fastened to a movable support so that the loop can be set near the circuit with which coupling is desired. A suggested support for the loop is shown in Fig. 5.

With the values shown below for L-1 and C-1, the tuning range of the device will include Forest Service frequencies between 2900 and 3500 kc, even with the rather wide variation in input capacitance encountered in oscilloscopes of different manufacture.

Following is a suggested parts list:

C-1	Tuning Capacitor 250 mmf. variable	Hammarlund	MC-250-M
L-1	Coil	30 turns of #20 enamel wire close-wound on National XR-1 form.	
	Socket, Coil-Form	(National (Hammarlund	XC-4) S-4)
	Dial, Tuning, 2-in.	Bud	D-711
	Wire for pick-up loop and twisted pair lead.	Lenz	Code 1090
	Tie point, 2-terminal	Cinch	1520

1.2 32-39 Mc Band

The ability to use one of the arrangements of Figs. 1, 2, or 3 for frequencies above 32 Mc depends upon the oscilloscope input circuit having suitable characteristics. In some instruments a large input capacitance prevents these circuits from being useful; in others the internal leads between the input terminals and the vertical-deflection

plates will not transmit frequencies of 32 Mc and higher. However there are oscilloscopes in which lead-lengths and input capacitances are sufficiently small to use one of the circuits suggested.

A few instruments have the ungrounded vertical-deflection plate brought directly to an external terminal. During usual use an external jumper connects this plate to the remainder of the internal circuit. When it is desired to apply high-frequency voltage to this plate, the jumper is removed, and normal bias is applied to the plate through a high resistance. If such an oscilloscope is at hand, one of the circuits of Figs. 1, 2, or 3 may be used with frequencies between 32 and 39 Mc. Of course it will be necessary to modify the circuit chosen to insure correct bias on the tube plate. Such a modification of Fig. 1 is shown in Fig. 4.

Mechanical details of the device should be such that short leads result from the tuned circuit to the oscilloscope input terminals, and so that the tuned circuit itself is compact. Since the coil is small, it may be soldered directly to the capacitor terminals. The construction of the pick-up loop and leads are similar to that described for the 3000-3500 kc range (see item 1.1). To minimize lead lengths, the ends of the twisted pair may be soldered directly to the capacitor rotor terminal and the tap point on the coil. Sizes of capacitor and coil shown in the following parts list provide the desired frequency range when connected to an instrument with very low input capacitance such as that described in the preceding paragraph. A coil of somewhat less inductance may be needed if the input capacitance is somewhat higher, but still low enough to permit this circuit to perform at frequencies over 32 Mc.

The suggested parts list follows:

C-1	Tuning Capacitor, 30 mmf variable	Hammarlund	HF-30X
C-2	Blocking Capacitor .0005 mf mica	(Aerovox (Solar	1466) MT-1322)
L-1	Coil	9 turns #18 enameled wire, self supporting, 9/16" inside diameter x 3/4" long.	
R-1	Isolating Resistor 0.5 Megohm, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$

2.0 Operating Instructions

1. Turn on the oscilloscope and adjust spot intensity, focusing, and centering of image on screen as outlined in the manufacturer's operating instructions. Switch off the internal amplifier.

2. Connect the external tuned circuit to the oscilloscope input. This connection should be made to the normal input terminals of the instrument if the tuned circuit is built as shown in Figs. 1, 2, or 3; it should be made to the terminal connecting directly to the ungrounded vertical-deflection plate if the tuned circuit is built as shown in Fig.4.

3. Provide means for modulating the transmitter with a tone of constant frequency and near sine-wave waveform. A satisfactory way of doing this is to apply the output of a tone oscillator with good wave form to the modulator input. The tone oscillator output may be connected to a plug which fits the microphone-cord socket on the transmitter. If a tone oscillator is used, the switch for timing-circuit control should be turned to "INTERNAL".

An alternate method of supplying modulation tone with good wave form is to whistle into the microphone. However, it is difficult to whistle with sufficiently constant pitch to make the image on the screen stand still. To overcome this difficulty, a-f voltage from the modulator may be introduced to the timing-circuit control. Connect a .002 mfd. 1250 WV mica capacitor in series with a 50,000 ohm $\frac{1}{2}$-watt resistor between the plate side of the modulation-transformer secondary and the ungrounded "EXTERNAL CONTROL" terminal on the oscilloscope. Connect the chassis of the radiophone to the oscilloscope ground. When using this arrangement the timing-circuit control switch should be turned to "EXTERNAL".

4. Turn transmitter on and adjust for normal loading. If possible, this should be done with a dummy antenna connected to the transmitter (see Sec. C12.403, "Dummy Antennas for Adjusting Transmitters"), thus eliminating the possibility of the transmitter causing interference while tests are being made. If no dummy antenna is at hand, the regular antenna may be used.

5. Couple pick-up loop to final-amplifier-plate coil in transmitter. Resonate the external tuned circuit to the transmitter frequency by tuning the pickup device capacitor for maximum amplitude of the image on the screen. If the image amplitude becomes too large, loosen the coupling between the pick-up loop and the transmitter plate coil. Do not detune pickup device to reduce size of pattern. Adjust the coupling so that image amplitude is about one third the screen diameter.

With the transmitter unmodulated, the image will be a luminous area bounded by parallel horizontal lines, as shown in Fig. 7. Individual r-f cycles will of course not be evident, because the sweep frequency is too low, and is not sychronized.

6. Modulate the transmitter with a tone of constant frequency, using one of the methods mentioned in paragraph (3). Adjust the

frequency of the oscilloscope sweep oscillator so that a few cycles of modulation-frequency wave appear. On most oscilloscopes sweep frequency is adjusted by means of two knobs, one of which is a tap switch that selects the frequency range, while the other is a vernier which adjusts the frequency within the range selected.

If the whistling method of modulation is used, as described in paragraph (3), the pitch of the whistle must be kept as constant as possible. For best wave form the microphone should be held vertical. The "SYCHRONIZATION" control should then be turned just far enough to the right so that the pattern stands still.

A typical resulting image with a moderate degree of modulation is shown in Fig. 6.

2.1 Interpreting the Images

(7) Proper interpretation of oscilloscope images will reveal a large amount of information concerning the conditions existing in the transmitter. The reader is referred to the works listed in Item 2.2, "References", for detailed information. The present discussion is limited to interpretations of a few typical patterns which may be encountered in the servicing of Forest Service radiophones. In particular, this information deals with analyzing such conditions as completeness of modulation, serious distortion, and accuracy of neutralization in neutralized amplifiers.

(8) Adjust modulator input so that about 100% modulation results. This is done by adjusting the level of the tone input to the modulator if a tone oscillator is used, or by directing the proper sound intensity into the microphone if the whistling method is used. A satisfactory method of varying the intensity of sound input to the microphone is to vary the position of the microphone while whistling.

If the transmitter is in good adjustment, the image will appear as shown in Fig. 8 when modulation is near 100%. The amplitude included between points A and A^1 at a modulation peak should be approximately double the amplitude of the unmodulated carrier. Modulation envelope should be curved at both the peaks (points A) and the troughs (points B). This assumes sine-wave input from the tone oscillator, or a whistling sound in the microphone. Other sounds will produce a different wave shape.

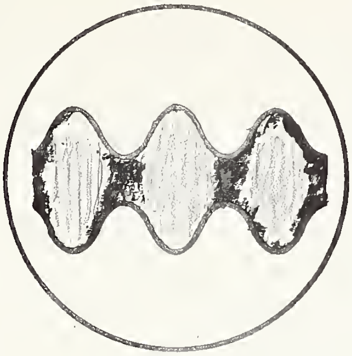

FIG. 6.
MODULATED CARRIER.

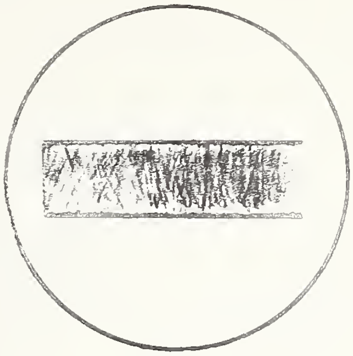

FIG. 7.
UNMODULATED CARRIER.

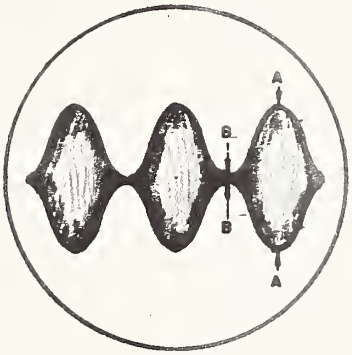

FIG. 8.
CARRIER MODULATED 100 %

FIG. 9.
MODULATED CARRIER SHOWING DISTORTION DUE TO UNBALANCE IN MODULATOR.

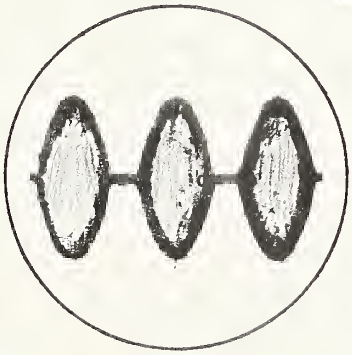

FIG. 10.
OVERMODULATED CARRIER, NEUTRALIZATION CORRECT.

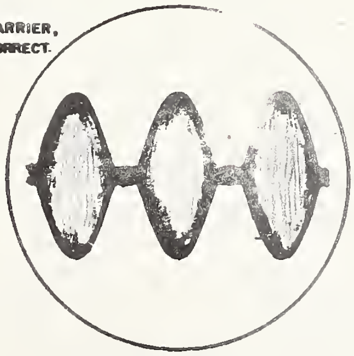

FIG. 11.
OVERMODULATED CARRIER, NEUTRALIZATION INCORRECT.

FIG. 12.
CARRIER SPEECH MODULATED, WITH UNSYNCHRONIZED LINEAR SWEEP ON OSCILLOSCOPE.

U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE	
TYPICAL OSCILLOSCOPE PATTERNS ENCOUNTERED DURING TRANSMITTER ADJUSTMENT	
DRAWN BY G. B. C. CHECKED BY E. H. S. DATE APR. 10, 1940	USFS RADIO LAB DRWG SI-0-41-B

FORM RL-3

(9) It may be observed that as the tone input to the modulator is gradually increased, the wave shape of the envelope becomes distorted before 100% modulation is reached; that is, before the troughs of the two sides of the envelope meet, as at point B in Fig. 8. This observation indicates distortion in the modulator, and should be followed by a check of operating voltages and components within the modulator. The image of Fig. 9 illustrates the distortion which occurs when one of the tubes in a class AB modulator is not operating.

(10) If the tone input to the modulator is increased considerably beyond that required for 100% modulation, the image should normally appear as shown in Fig. 10. During a portion of the modulation-frequency cycle the plate voltage on the final amplifier is very low, or has actually become negative, and there should be no r-f output. Accordingly, the image has zero height during this interval, as shown in the portion C-D of Fig. 10. A flattening of the modulation peaks may also be in evidence, and is caused by the modulator operating at levels higher than the range for which it was designed.

(11) If the final amplifier is imperfectly neutralized, some r-f energy will appear in the final-amplifier-plate circuit due to interelectrode tube capacitance, even when the plate voltage is very low or actually negative. Thus if a transmitter with a poorly neutralized final amplifier is overmodulated, the image will differ from that of Fig. 10 in that the portion between C and D will not be a narrow line, but will have some height, corresponding to the r-f energy present in the plate circuit due to tube-capacitance coupling to the driver circuit. To observe whether the portion between C and D is a sharp line, oscilloscope spot must be in sharp focus. A typical image observed under these conditions is shown in Fig. 11.

The above facts make it possible to perform the neutralizing adjustment using the oscilloscope. The transmitter is overmodulated with a tone of constant frequency, as explained above, and the neutralizing adjustment is manipulated for minimum width of the portion C-D in the image of Fig. 11.

(12) The next step is a test to determine whether the transmitter modulates satisfactorily with normal voice input. Disconnect the tone oscillator if one was used, and re-connect the microphone to the modulator input. Speak close to the microphone, at a conversational voice level, just as during normal use of the radiophone. Without making any effort to synchronize the sweep oscillator with the frequency of your speech, note the pattern on the screen. In general the envelope will be indefinite and constantly changing, since the sweep oscillator is not synchronized. Whenever overmodulation occurs, a bright line will appear along the horizontal axis superimposed over the irregular image. Normally, such modulation peaks of over 100% should occur infrequently. It should be possible, by raising one's voice, to cause the bright lines to appear during every strong syllable.

2.2 References

Rider, John F., "The Cathode-Ray Tube at Work", John F. Rider, Publisher, 404-4th Avenue, New York, N. Y. 1935.

This book discusses the fundamental principles and practical applications of the cathode-ray oscilloscope in easily understood non-mathematical language.

"The Radio Amateur's Handbook", current edition, published by American Radio Relay League, West Hartford, Connecticut. Section headed "Use of the Cathode-Ray Oscilloscope".

This section is a condensed discussion concerning the use of the oscilloscope in analyzing conditions in a transmitter. Several typical patterns are interpreted, and certain troubles which sometimes arise in obtaining the patterns are explained.

C12.403 Dummy Antennas for Adjusting Transmitters

C12.500 SERVICING NOTES, MISCELLANEOUS

Radio Hdbk
Added 10-16-39
No. 1

C12.501 Removal of Old "C" Batteries

Radio Hdbk
Added 10-16-39
No. 1

C12.501 Removal of Old "C" Batteries

"C" batteries in radiophones should be inspected at intervals of 6 months or a year. Inspection should include measurement of voltage and observation whether the battery is giving off fluid or other products. Batteries which are old, or which have less than normal voltage, or which are giving off fluid should be removed from the radiophone. An old battery which is not yet giving off fluid may be expected to do so after a time. These products are highly corrosive to metal surfaces. Also, the fluid will moisten long lengths of fabric insulation on connecting wires by "wicking" action, and will make the wire covering partly conducting. The covering will remain conducting after the fluid has dried out.

If the metal surfaces show evidence of a battery once having discharged corrosive products, the insulation on each wire terminating at the "C" battery should be tested. Defective insulation may permit small leakage current to flow from the "C" battery to ground, thereby discharging the battery after a comparatively short time. An ohmmeter with a high-resistance scale is suitable for this test. Disconnect the wire under test from the battery, touch one ohmmeter prod to the conductor, and scrape the other prod along the surface of the insulation. If the wire covering has ever been wet with fluid from a battery, a resistance of between 50,000 and 500,000 ohms may be noted. Defective wires should be replaced.

Batteries will deteriorate more rapidly in dry hot climate than under cool humid conditions. Thus, frequency of "C" battery inspections may be gauged by local conditions.

If a "C" battery is removed from a radiophone and not immediately replaced, for instance, due to the necessity of waiting for an order to be filled, a note stating the absence of the "C" battery should be inserted in the kitbox where it will be noticed immediately on opening the cover. This procedure will lessen the likelihood of the radiophone being taken out for use before the new battery is installed.

C12.6 SERVICE RECORDS

Radio Hdbk
Added 10-16-39
No. 1

C12.6 Service Records

The Regional Radio Engineer and the Forest Technician will find it helpful to keep records of service work. Mimeographed forms will simplify this work, and will tend to prevent important omissions from records. A suggested form for this use follows on reverse side of this page.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

RADIO SERVICE REPORT FORM

Type______ Serial______ Date______ Forest__________ Location__________

TUBES

Transmitter Type		Receiver Type	
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)
________	(__)	________	(__)

BATTERIES

A Battery No. ____________
Number used ____________
Voltage ____________
B Battery No. ____________
Number used ____________
Voltage ____________
C Battery No. ____________
Voltage ____________

- -

TRANSMITTER

Filament Voltage ________ v.
Final Plate Current ________ Ma.
Osc. Plate Current ________ Ma.
Grid Current ________ Ma.
Neutralization ________
Frequency ________ Mc.
General Condition ________
Modulation ________
Meter Condition ________

RECEIVER

Filament Voltage ________
Plate Current Drain ________
Frequency Coverage____Mc.to______Mc.
Sensitivity (listening) ______
General Condition ______

GENERATOR

Serial No. ______
Brushes ________ Gas Engine ______
Wiring ________ Cleaning ______

- -

ANTENNAS

Dimensions ____________
Condition of Wire ____________
Connections ____________
Insulators ____________
Sash Cords ____________
Portable Reels ____________
Kit Bag Contents ____________

REPAIR PARTS

____
____
____
____
____
____
____

General remarks and recommendations: ____________________
____
____
____

Signed: ____________________

C13.0 SERVICE DATA SHEETS

Radio Hdbk
Added 10-16-39
No. 1

C13.0 SERVICE DATA SHEETS

The following sections comprising Data Sheets on the several types of Forest Service radio equipment are each complete in themselves and contain indices for each set of sheets. Additional folders of Data Sheets are obtainable separately from the rest of the Handbook.

As additional Data Sheets are prepared, they will be circulated as supplements to this Handbook.

C13.1 Service Data Sheets

Type SPF

Model AA Nos. 265 to 480 Inc.

Model AB Nos. 481 to 743 Inc.

Model AD Nos. 744 to 903 Inc.

Model AE Nos. 904 to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Note: For operating information see "Instructions for Operating," furnished with radio set.

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0.2 Physical Specifications

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1.2 Receiver Circuit

1.3 Power Supply Circuit

1.4 Switching Circuits

1.5 Other Features

PART 2

2.0 Adjustment and Repair, General

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2.2 Receiver Data

2.3 Power Supply Data

2.4 Switching Circuit Data

2.5 Parts List

2.6 Diagrams

2.7 Additional Data

0.0 General Description

The Type SPF Radiophone is a portable, dry-battery operated transmitter-receiver, which operates in the frequency range 2900 to 3500 kilocycles. The Type SPF will transmit and receive both voice and telegraph signals. Transmission and reception do not take place simultaneously, but alternately.

Two sets of batteries and two antennas are provided. Normal duty batteries and a substantial half-wave antenna are included for use at semi-permanent locations where operation over a moderately long period is contemplated. Light weight batteries, a flexible wire antenna, and a canvas kit bag are provided for use where extreme portability and ease of setting up quickly in the field are required.

A rugged wooden kitbox is furnished for containing the Radiophone both sets of batteries, and all accessories when it is being transported. The entire equipment weighs about 60 pounds when packed. The canvas kit bag, with Radiophone, light weight batteries, flexible wire antenna, and telegraph key weighs 22 pounds.

The Type SPF Radiophone consists of a crystal-controlled transmitter, with an output of $2\frac{1}{4}$ watts, and a superheterodyne receiver. Both units are contained on a single compact chassis and housed in a rugged plywood cabinet. The operating frequency of the transmitter is one of the frequencies between 2952 and 3445 kilocycles assigned to the Forest Service. The receiver is equipped with both loudspeaker and headphones and may be tuned continuously over the range of 2952 to 3445 kilocycles.

0.1 Electrical Specifications

Power Supply	Dry Batteries. Two types, heavy duty and light (portable)
Frequency Range	2952 to 3445 kilocycles (crystal controlled)
Power Output	2.25 watts
Working Range	10 - 20 miles
Antenna	Half-wave, fed off-center, or end-fed type
Tube Complement, Transmitter	Type 1H4G oscillator Type 1J6G final amplifier Type 1F5G speech amplifier Type 1J6G modulator

0.1 Electrical Specifications (cont'd)

Tube Complement, Receiver	Type 1D5G r-f amplifier Type 1D7G oscillator-mixer Type 1D5G i-f amplifier Type 1D5G detector and b-f oscillator Type 1F5G audio amplifier
Input to Transmitter	Microphone or key
Type of Transmission	Voice or cw telegraphy
Output	Loudspeaker or headset

0.2 Physical Specifications

Overall Dimensions, carrying case (kitbox)

Height	8-1/2	inches
Width	16-1/2	"
Length	25	"
Weight, packed for transport	60	pounds

Overall Dimensions, Radiophone only

Height	6-1/2	inches
Width	9	"
Depth	14-1/2	"
Weight	12-1/4	pounds
Weight of kit bag and light weight batteries	9	"

PART 1

1.0 Detailed Description

The transmitter and receiver are located on a single chassis, with the transmitter occupying the right-hand half and the receiver the left-hand half, viewed from the front. Parts may be identified from the Parts List (2.5), the Schematic Diagram (2.62), and the Photodiagram (2.63).

1.1 Transmitter Circuit

The transmitter consists of an r-f section with crystal-controlled oscillator and final amplifier, and an a-f section with speech amplifier and modulator stages.

The r-f section of the transmitter consists of the crystal-controlled oscillator VT1 and the final amplifier VT2. Resistor R1 is the grid return resistor for VT1. Plate circuit L1-C1 is fed through resistor R2 and bypassed by capacitor C2. Grid excitation for the final amplifier is supplied by the voltage induced in coil L2 which feeds the grids of VT2, connected in parallel. Bias voltage is furnished by the voltage drop across resistor R3, which is by-passed by capacitor C3. The plates of the final amplifier are fed through RFC1, and the neutralizing is effected by capacitor C4. The antenna coupling circuit comprises blocking capacitor C5, tuning capacitor C6, tuning coil L3, and the antenna loading capacitor C8 in parallel with C7, adjustable.

Variations of the microphone current through the primary of transformer T1 cause a varying voltage to be impressed upon the grid of the a-f amplifier VT3. Its plate current is supplied through the primary of transformer T2, whose secondary voltage is applied to the grids of the modulator VT4, which is connected in push-pull, class B. The plates are connected to the modulation transformer T3, through whose secondary the plate current for the final amplifier is passed, thus effecting plate modulation of VT2. The meter with the 50 milliampere shunt, R301, is also connected in series to indicate the current of the final stage, and thus serve as a check on resonance and loading in the final stage.

1.2 Receiver Circuit

Signals from the antenna are applied to r-f transformer L101 and induce a voltage in its secondary, L102, which is tuned with capacitors C101 and C102. The voltage across this circuit is fed to the grid of the r-f amplifier tube, VT101, whose plate works into r-f transformer L103-L104. The output of this transformer is tuned by capacitors C104 and C105 and is applied to the control grid of the mixer tube, VT102. The oscillator section of this circuit comprises coils L105 and L106, tuned with capacitors C106 and C107. C112 is the mixer screen bypass capacitor.

Capacitors C101, C104, and C107 are ganged together on a single shaft, controlled by the tuning dial.

The oscillator grid of VT102 is supplied through coupling capacitor C108 and receives its bias from the voltage drop across resistor R101. The anode grid is coupled to the oscillatory circuit through capacitor C109. The plate of this tube feeds into the first i-f transformer L107-L108 whose primary and secondary are tuned by capacitors C110 and C111 respectively. Tube VT103, the i-f amplifier, feeds into second i-f transformer L109-L110, tuned by capacitors C115 and C116.

Tube VT104 is the second detector and b-f oscillator. The latter function takes place between the oscillator grid and anode grid in conjunction with coil L111 and capacitor C118, which form the tuned circuit. The oscillator grid is fed through capacitor C117, with its bias derived from the voltage drop in resistor R104. The anode grid is fed through capacitor C119 and dropping resistor R105. The b-f oscillator is controlled by switch SW3. The plate of VT104 receives its current through the filter circuit consisting of resistor R106 and capacitor C120 and the plate resistor R107. Resistor R109 and capacitors C122 and C123 make up the r-f filter in the plate circuit. The grid of the a-f tube VT105 is fed through capacitor C124 and is furnished with bias voltage through resistor R110. The plate current flows through the primary of the output transformer T101 whose secondary may be switched to either loudspeaker or headphones by switch SW2 marked "SPEAKER-PHONES." Microphone, speaker, and headphones are all connected to a single plug, P1, which plugs into socket S1.

Voltage for the screens of tubes VT101 and VT102 is reduced to the proper value through resistor R111. Screen voltage for VT103 is reduced manually by potentiometer R103, the volume control. Capacitor C113 bypasses this circuit. Screen voltage for VT104 is separately furnished through resistor R108, which is bypassed by capacitor C121. Capacitor C126 is a bypass for the plate voltage supply.

1.3 Power Supply Circuit

Power for the entire Type SPF Radiophone is supplied from dry batteries. The normal-duty batteries, both "A" and "B", occupy a compartment in the wooden kitbox. The light weight "A" and "B" batteries occupy compartments in the canvas kit bag. The "C" battery is small, and is clamped in place on the lower side of the Radiophone chassis.

Two cables are provided, one for the normal-duty and one for the light weight batteries. Each cable terminates in a resilient rubber covered plug. Either set of batteries may be connected to the Radiophone by plugging the proper cable terminal into the socket on the front panel.

When the normal duty batteries are in use, two "B" voltages are used, 135 and 180 volts. When the light weight batteries are used, the 135 and 180 volt buses are paralleled and connected to the nominal 144 volts from the stick type battery.

Proper filament voltage is maintained on the receiver tubes by the Type 1B1 ballast tube, VT201. Transmitter filament voltage is controlled by the rheostat R5, marked "Fil" on the front panel. When the telegraph

key is plugged into jack J1 for telegraph transmission, filaments of audio tubes VT3 and VT4 are disconnected, and R6 is inserted in series with filaments of VT1 and VT2, to compensate partially for the change in drop across rheostat R5.

Battery drains are approximately as follows. These figures are for the normal-duty connection, and the "B" drain will be somewhat less for the light weight battery connection.

Battery	Transmit Phone	Transmit CW	Receive
A	700 m.a.	320 m.a.	370 m.a.
B 135-v	10	0	16
B 180-v	60	35	10

1.4 Switching Circuits

Switch SW1 serves both as an on-off switch and transmit-receive switch. In the "TRANS." position, the battery and antenna leads are connected to the transmitter and the receiver is entirely disconnected; in the "RECV." position the same leads are connected to the receiver and the transmitter is inoperative; in the "OFF" or center position these leads are disconnected from both transmitter and receiver.

The meter on the panel may be switched to read either the filament voltage on the transmitter ("TRANS. FIL"), the battery voltage ("B VOLTS"), or the plate current of the final stage ("TRANS. TUNE"). This operation is performed with switch SW4 and associated resistors, R303 in series in the transmitter filament circuit, R302 in series in the 180-volt "B" battery lead, and R301 in shunt in the plate circuit of the final amplifier.

For cw telegraph operation, inserting the key plug in jack J1 in the rear of the set places the key in series between grid resistor R3 and ground, opens the filament circuit of the microphone amplifier and modulator, and connects a resistor R6 in series with the filaments of the transmitter tubes to compensate for the current taken by the filaments of the microphone amplifier and modulator tubes during phone operation. In making code signals, the oscillator continues to run while the final amplifier is cut in and out with the key, which closes and opens its grid return circuit.

2.0 Adjustment and Repair, General

The following tools and equipment are needed for adjusting and aligning the Type SPF radiophone.

(a) Usual complement of bench and hand tools for servicing.

(b) Tube checker.

(c) High resistance d-c voltmeter -- 1000 or more ohms per volt. Scales, 0-10, 0-50, and 0-250 volts.

(d) Ohmmeter.

(e) Cathode ray oscilloscope.

(f) Signal generator, 2900 to 3500 kc; also 465 kc for i-f alignment.

(g) Dummy antenna, consisting of .00015 mf capacitor in series with 500-ohm 2-watt non-inductive resistor.

(h) Tuning wand, such as Aladdin Resonator.

(i) Output meter, capable of measuring 50 milliwatts into a 6000-ohm load. If item (c), above, has a 0-10 volt a-c scale, it may be used in place of the output meter, provided the a-c scale operates from a dry-disc rectifier.

(j) 0-25 ma d-c milliammeter.

General Procedure

(a) Inspect battery connections to see that they are in accordance with instructions. Measure all battery voltages. Battery voltages should be measured with the transmitter in operation, and with the final stage resonated.

Turn SW1 to "TRANS.", and SW4 to "TRANS. FIL." Turn "FIL." knob (R5) to right, until meter reads 2.15 volts (red line on meter). Quickly turn SW4 to "TRANS. TUNE," and adjust C6 for minimum meter reading. With SW4 in "TRANS. FIL." position, if turning "FIL." knob all the way to the right does not bring meter reading to 2.15 volts, "A" battery must be replaced. Turn SW4 to "B VOLTS." If meter reads less than 120 volts, the "B" battery should be replaced. This procedure should be followed for both heavy-duty and light weight batteries, if use of both sets of batteries is contemplated.

Measure "C" battery voltage with high resistance voltmeter. Replace if it reads less than 4.2 volts. This measurement may be taken with the Radiophone turned off.

(b) Check tubes. If no tube checker is available, the tubes may be tried in another Type SPF Radiophone known to be in good working order. Work the tubes in and out of their sockets a few times to improve contacts.

(c) Measure all transformer winding resistances and compare with values marked on the Photodiagram, 2.63. Values shown on Fig. 2.63 are correct for Type SPF, Model AA (Serial numbers 265 to 480, incl.). For Model AB (Serial numbers larger than 481), resistances of all transformers except T101 are unchanged. For T101 in the Model AB, primary is 900 ohms, secondary 1/2 ohm.

(d) See that the stators of receiver tuning capacitors have not become loose or shifted to the extent that contact with rotors occurs, or is likely. Contact between stator and rotor will result in short-circuiting of "C" battery. If stators are loose or shifted, it will be necessary to remove capacitor from chassis, carefully re-align and tighten stator, then re-align receiver circuits as outlined in Section 2.2 hereinafter.

(e) Inspect Radiophone for open circuits, broken wires, mechanical damage, and unsoldered connections. See that switches SW1 and J1 are making good contacts.

(f) If set still fails to operate satisfactorily, make a detailed check of the circuit using the Schematic Diagram, Fig. 2.62, the Photodiagram, Fig. 2.63, and the Parts List, 2.5.

If meter requires repair on the Model AA, send the entire Radiophone to service headquarters. Entire Radiophone must be sent, because meter must be adjusted with its shunts. In the Model AB, send only the meter and the sub-panel which holds its shunts.

2.1 Transmitter Data

In case it is necessary to change the frequency of an SPF set, the following procedure may be used. The same routine may be followed for a check-up of the tuning adjustments without changing the crystal itself (omit items 2 and 3).

1. Remove set from case, after taking out screws from rear and sides.

2. Loosen nuts holding crystal holder and connecting lead and remove crystal holder.

3. Install new crystal holder with crystal in place and tighten down nuts and connecting lead.

4. Disconnect plate voltage from final stage by disconnecting plate lead from tie-point TS1.

5. Connect a 0-25 milliammeter in parallel with resistor R2, using great care that neither side of the instrument or its leads become grounded to the chassis. Accidental contact of one meter lead to ground will result in damage to meter. This will measure the plate current of the oscillator.

6. Connect the battery cable and place SW1 in "TRANS." position.

7. Starting with the plates <u>fully meshed</u>, gradually open the plates of capacitor C1 until the plate current drops from its initial value of about 15 milliamperes to something less than 8 or 9 milliamperes.

8. Continue to open the plates of the capacitor until a current of 10 milliamperes is indicated.

9. It is important that the current be reduced to the lowest value and then brought up again to about 10 milliamperes by rotating the capacitor from fully meshed toward open position.

10. The next step is the neutralization of the final stage. Disconnect plate voltage from VT-2. Using the rectifier-wavemeter connection, resonate the USFS Type A Test Meter to transmitter frequency by coupling its coil to oscillator coil L1, and adjusting dial for maximum Test Meter deflection. Coupling should not be closer than necessary to produce a meter indication.

With Test Meter tuning undisturbed, couple Test Meter coil to final tank coil, L3. Resonate final tank circuit by varying C6. Resonance will be indicated by maximum current in Type A Test Meter. Coupling between L3 and the Test Meter coil should be adjusted so that this maximum current is somewhat above mid-scale. Vary C4 for minimum or zero Test Meter Current. An alternate method of neutralizing, making use of the oscilloscope, is stated in paragraphs 11 to 14, inclusive.

*11. Adjust the pick-up circuit of the oscilloscope to the frequency of the crystal by coupling it to the plate coil of the oscillator coil L1 and couple the pick-up coil of the oscilloscope to the final tank coil of the output stage, L3.

---

*If neither Type A Test Meter nor oscilloscope is available, disregard Items 10 to 15, incl., and neutralize by method indicated in Item 18. Follow by attaching dummy load as in Item 15 and adjust loading as in Item 17.

12. Disconnect the antenna or other loading from the final tank circuit if present.

13. Tune the final tank circuit to resonance, as indicated by maximum deflection on oscilloscope screen. (Plate voltage still disconnected.)

14. Adjust neutralizing capacitor C4 for minimum deflection on the oscilloscope.

15. Attach the dummy load consisting of a 500-ohm, 2-watt resistor in series with a .00015 mf capacitor from antenna to ground (panel of set).

16. Reconnect plate voltage to final amplifier on tie point TS-1.

17. Adjust loading and resonance (see operating instructions).

18. Test accuracy of neutralization by plugging 0-25 milliammeter into key jack and see that minimum plate current and maximum grid current occur at the same setting of the resonance capacitor (C6). If neutralization has not been realized, adjust neutralizing condenser C4 until maximum grid current and minimum plate current of the final stage are coincident. This condition is checked by varying the tuning of the final stage slightly on each side of resonance and noting the variation in grid current at the same time. Under perfect neutralization grid current will begin to fall immediately <u>on each side of resonance</u> as plate current begins to rise.

19. Check modulation. This is done best by observing the pattern on the oscilloscope screen.

20. After the foregoing adjustments have been made, final plate current off-resonance should be observed. With SW4 in "TRANS. TUNE" position, turn C6 far off resonance <u>momentarily</u>. Plate current should rise to 50 or more milliamperes. Failure of plate current to come up to this value indicates either a poor Type 1J6G output tube, or insufficient excitation. Obviously, low current due to a poor tube will be corrected by insertion of a good tube. Insufficient excitation may be caused by an inactive crystal, low battery voltages, or improper oscillator adjustment.

The final tube must not be allowed to operate at this abnormally high current for more than the few seconds necessary to obtain the current reading, or the emission of the tube will be impaired permanently.

2.2 Receiver Data

Proper performance of the Type SPF receiver depends upon the correct alignment of the r-f and i-f tuned circuits. This alignment should be undertaken only by a qualified technician, and only if the receiver is actually in need of alignment. The alignment procedure is as follows:

(a) Set the signal generator frequency at 465 kc. Connect ground on the signal generator to the chassis of the Radiophone, and connect the signal generator output to the grid of the converter, VT-102, through a .001 mf mica capacitor. The grid clip which is normally connected to the grid cap of VT-102 is now connected to the grid cap through a 1-megohm 1/2-watt resistor.

(b) Turn SW1 to "RECV.," SW2 to "SPEAKER," and turn the "VOLUME" knob, R103, all the way to the right. Adjust capacitors C110, C111, C115, and C116, the padders in the i-f transformers, for maximum volume in the speaker.

(c) If an output meter is at hand, connect it in place of the headphones. Load resistance of the meter should be set at 6000 ohms. If the a-c voltmeter is to be used for output indication, leave the headphones in the circuit, and connect the voltmeter leads in parallel with them. A 1-mf condenser should be connected in series with the a-c voltmeter. Turn SW2 to "PHONES." Readjust padding capacitors C110, C111, C115, and C116 for maximum deflection of the needle. If the needle goes off scale, lower the input from the signal generator.

(d) Disconnect signal generator from converter tube, and reconnect grid clip of converter tube, VT-102, for normal operation. Set signal generator frequency at 3500 kc and connect attenuator output of generator to antenna post of receiver through a 400-ohm 1/2-watt non-inductive resistor. Connect ground terminal of signal generator to Radiophone chassis.

(e) Switch SW2 to "SPEAKER." Tune in the signal with the tuning dial. The signal should come in when the dial reads about 90. If the dial reading differs from this considerably, turn the dial to 90, and tune the signal in with the oscillator padding condenser, C106. Turn SW2 to "PHONES." Tune receiver dial for maximum deflection. If needle goes off scale, lower the signal input from signal generator.

(f) With the receiver operating, vary C102 by means of a screw driver, until maximum output meter reading is obtained. It is necessary to rock the tuning condenser back and forth across resonance while seeking an adjustment of C102 which gives the greatest meter deflection when the tuning condenser crosses resonance.

(g) Adjust C105, using the technique outlined in (f).

(h) Set frequency of signal generator at 2900 kc. Switch SW2 to "SPEAKER," and tune in signal. Signal will come in near 20 on the dial. Switch SW2 to "PHONES," thereby connecting output meter. Set the Radiophone on its right side and tune for maximum deflection. Insert each end, in turn, of the tuning wand into L101-L102. If the needle shows a marked increased deflection upon insertion of either end, plates of tuning capacitor C101 must be bent. If increased deflection of meter is observed when brass plug end of wand is inserted, then capacitance of C101 must be decreased. If increased deflection of meter is observed when powdered iron end of wand is inserted, then C101 must be increased. Bending should be done on the rotor plates, and the plates must be unmeshed, and the battery plug disconnected for this operation. Make all changes by small amounts, making frequent checks with the wand. Make certain that the plates do not touch in any position of the tuning capacitor. Contact between rotor and stator plates will result in "C" battery being short-circuited.

(i) Adjust condenser plates on C104, inserting the wand into L103-L104, using the technique outlined in (h).

(j) Readjust C110, C111, C115, and C116, always seeking maximum deflection of output meter needle.

(k) With all of foregoing adjustments made and checked, tune the receiver for maximum deflection of output meter. Switch SW2 to "SPEAKER." Turn off modulation in signal generator, and turn on b-f oscillator in receiver by use of SW3. A loud whistle should be heard in the speaker, with a pitch not exceeding 1000 cycles, and preferably as low as possible. This pitch may be adjusted by the capacitor C118 in the top of the b-f oscillator shield. It will be found that as the pitch is made low and approaches zero, an unstable condition is obtained, such that the beat frequency jumps suddenly as the receiver dial is tuned across the signal. The pitch should be made just high enough so that this unstable condition does not exist, and in no case more than 1000 cycles.

(l) With the receiver aligned, a 50 milliwatt output should be present in a 6,000-ohm load, with a signal input of from 5 to 12 microvolts.

(m) Re-connect headphones, disconnect meter.

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
C1	Oscillator plate tuning	50 mmf	Hammarlund	APC-50	
C2	Oscillator plate bypass	.001 mf	(Aerovox (Solar	1465) MT)	
C3	Final amplifier grid bypass	.001 mf	(Solar (Aerovox	MT) 1465)	
C4	Final amplifier neutral-izing	70 mmf	Hammarlund	MICS-70	
C4A	Final amplifier neutral-izing series	.0005 mf	(Solar (Aerovox	MT-1322) 1466)	
C5	Final plate coupling	.001 mf	(Solar (Aerovox	MT) 1465)	
C6	Final plate resonating	100 mmf	Hammarlund	SM-100	
*C7	Antenna loading	(70 mmf variable (250 mmf variable	Hammarlund Hammarlund	MICS-70 QTD-250	Note 12 Note 13
*C8	Antenna loading	(50-100 mmf fixed (250 mmf variable	Solar Integral with	MT C7	Note 12 Note 13
C101	R-f grid tuning				Note 1
C102	R-f grid padding	(70 mmf (100 mmf	Hammarlund Mallory	MICS-70 CTX-954	Note 6 Note 7
C103	R-f grid bypass	.1 mf	Solar	MP-4147A	
C104	Mixer grid tuning				Note 1
C105	Mixer grid padding	(70 mmf (100 mmf	Hammarlund Mallory	MICS-70 CTX-954	Note 6 Note 7

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C106	Oscillator padding	(70 mmf (100 mmf	(Hammarlund (Mallory	MICS-70 Note 6 CTX-954 Note 7
C107	Oscillator tuning			Note 1
C108	Oscillator grid coupling	50 mmf	(Solar (Aerovox	MO) 1467)
C109	Anode grid coupling	.001 mf	(Solar (Aerovox	MT) 1465)
C110	Mixer plate tuning			Note 2
C111	I-f grid tuning			Note 2
C112	Converter screen bypass	.1 mf	Solar	MP-4147A
C113	Volume control bypass	.1 mf	Solar	MP-4147A
C114	Filament bypass	.25 mfd 200-V paper	(Solar (Aerovox	S-0245) 284)
C115	I-f plate tuning			Note 3
C116	Detector grid tuning			Note 3
C117	B-f oscillator grid coupling	.00025 mf		Note 4
C118	B-f oscillator tuning			Note 4
C119	B-f anode grid coupling	.001 mf		Note 4
C120	Detector plate bypass	.1 mf	Solar	MP-4147A

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
C121	Detector screen bypass	.1 mf	Solar	MP-4147A	
C122	Detector r-f filter	500 mmf	(Solar (Aerovox	MT) 1468)	
C123	Detector r-f filter	500 mmf	(Solar (Aerovox	MT) 1468)	
C124	A-f grid coupling	.01 mf	(Solar (Aerovox	S-0219) 484)	
C125	135-V supply bypass	.5 mf 400-V	(Cornell-Dubilier (Solar	DB-4050 S-0263	Note 14 Note 15
C126	180-V supply bypass	.5 mf 400-V	(Integral with C-125 (Solar	 S-0263	Note 14 Note 15
C127	A-f screen bypass	.1 mf	Solar	MP-4147A	Note 8
C128	Filament bypass	.1 mf	Solar	MP-4147A	Note 8
C129	Filament bypass	.1 mf	Solar	MP-4147A	Note 8

Note 1: C101, C104, C107 -- on same shaft, special 3-gang capacitor, 25-50-25mmf sections. Hammarlund Type 61-2596-889.
Note 2: In first i-f transformer case.
Note 3: In second i-f transformer case.
Note 4: In b-f oscillator case.
Note 6: Only on serial numbers including and below SPF 532.
Note 7: Only on serial numbers including and above SPF 533.
Note 8: In Models AD and subsequent.
Note 12: In Model AA only.
Note 13: In Models AB and subsequent.
Note 14: In Models AA, AB, AD only.
Note 15: In Models AE and subsequent.
Note 16: In Models AA, AB only.
Note 17: In Model AB only.

2.52 Inductors

SYMBOL	COMPONENT	NUMBER OF TURNS	WIRE	FORM DIAMETER	MANUFACTURER	TYPE
L1	Oscillator plate	50	#28 enamel	1 inch)	Miller	9389
				)		
L2	Final amplifier grid	50	#30	13/16 ")		
L3	Final amplifier plate (Form National XR 2)	53	#24	1 "	Radio Specialty Co.	
L101) and) L102)	1st r f transformer				Miller	Style 1583, Type 32-618 A
L103) and) L104)	2nd r f transformer				Miller	Style 1583, Type 32-619
L105) and) L106)	H-f oscillator transformer				Miller	Style 1583, Type 32-620
Above 3 items are special						
L107) and) L108)	1st i-f transformer				(Aladdin (Meissner	C-101-M 01638
L109) and) L110)	2nd i-f transformer				(Aladdin (Meissner	C-200-M 01640
L111	B f oscillator coil				(Aladdin (Meissner	C-350 Note 9 01642
RFC1	Plate choke				National	R 100

Note 9: The Aladdin Type C-350 is not used as supplied by Aladdin. Connections are revised to conform with schematic diagram.

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
R1	Oscillator grid	50,000 ohms	I.R.C.	BT½	
R2	Oscillator plate dropping	500 "	I.R.C.	BT½	
R3	Final grid bias	2,000 "	I.R.C.	BT½	
R4	A-f transformer loading	40,000 "	I.R.C.	BT½	
R5	Transmitter filament	6 "	Mallory	C6R	
R6	Transmitter filament	1 "	I.R.C.	BW½	
R101	Oscillator grid bias	(50,000 " (0.2 megohm	I.R.C. I.R.C.	BT½ BT½	Note 16 Note 8
R102	Anode grid dropping	(25,000 ohms (0.1 megohm	I.R.C. I.R.C.	BT½ BT½	Note 16 Note 8
R103	Volume control	1 megohm Curve #2	Centralab	1-010-000 (Special)	
R104	B-f oscillator grid bias	.1 "	I.R.C.	BT½	Note 4
R105	B-f oscillator anode grid	.1 "	I.R.C.	BT½	
R106	Detector plate filter	(50,000 ohms (Deleted	I.R.C.	BT½	Note 16 Note 8
R107	Detector plate	(75,000 ohms (0.1 megohm	I.R.C. I.R.C.	BT½ BT½	Note 16 Note 8
R108	Detector screen	.1 megohm	I.R.C.	BT½	
R109	R-f filter detector plate	(25,000 ohms (10,000 "	I.R.C. I.R.C.	BT½ BT½	Note 12 Note 13

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
R110	A-f grid	.25 megohm	I.R.C.	BT½	
R111	Screen voltage dropping	(12,000 ohms (15,000 " (0.1 megohm	I.R.C. I.R.C. I.R.C.	BT-1 BT½ BT½	Note 12 Note 17 Note 8
R111A	Screen dropping	(40,000 ohms (15,000 ohms	I.R.C. I.R.C.	BT-1 BT½	Note 17 Note 8
R-112	A-f amplifier screen	0.15 megohm	I.R.C.	BT½	Note 8
R301	50-milliampere meter shunt	(Individually adjusted (Special		Special	Note 12 Note 10
R302	200-V meter scale multiplier	(40,000 ohms (40,000 ohms	Ohmite	Wirewatt	Note 12 Note 10
R303	5-V meter scale mul[illegible] multiplier	(1,000 ohms (1,000 ohms	Ohmite	Wirewatt	Note 12 Note 10

Note 10: In Models AB and subsequent, shunt and multiplier resistors are supplied by meter manufacturer.

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE	
VT1	Crystal oscillator	Sylvania	1H4G	
VT2	Final amplifier	"	1J6G	
VT3	Speech amplifier	"	1F5G	
VT4	Modulator	"	1J6G	
VT101	R-f amplifier	"	(1D5G (1N5G	Note 16 Note 8
VT102	Mixer	"	(1D7G (1A7G	Note 16 Note 8
VT103	I-f amplifier	"	(1D5G (1N5G	Note 16 Note 8
VT104	Detector and b-f oscillator	"	(1D7G (1A7G	Note 16 Note 8
VT105	A-f amplifier	"	(1F5G (3Q5GT	Note 16 Note 8
VT201	Voltage regulator	"	1B1	Note 16

2.55 Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T1	Microphone	Phelps-Dodge	Inca 04961
T2	Driver	" "	" 04792
T3	Modulation	" "	" 04791
T101	Output	" "	" 04795 Note 12 " 06956 Note 13

2.56 Switches

SYMBOL	COMPONENT	MANUFACTURER	TYPE
SW1	Send-receive, 3PDT	Federal	1424
SW2	Loudspeaker-headphone, SPDT	H & H	Small toggle, short nickel pl. shank
SW3	B-f oscillator, SPST	H & H	Small toggle, short nickel pl. shank
SW4	Meter range	Mallory	1315L

2.58 Batteries

QUANTITY	USE	MANUFACTURER	TYPE
4	Normal-duty (kit box) A	General Eveready	#6 7111 or #6 Ignitor
1	Lightweight (portable) A	General Eveready Burgess	4H2 X-248 or 723 2F2H
4	Normal-duty (kit box) B	General Eveready Burgess	V-30-B 762-S or 762 5308
1	Lightweight (portable) B	General Eveready Burgess	P-96-AA X-128 Z-96-P
1	C	General Burgess	H-3-AF A-3-BPX

2.59 Miscellaneous

QUANTITY	COMPONENT	MANUFACTURER	TYPE	
1	Crystal, A-cut, in holder (Specify frequency when reordering)	(Radio Specialty (Sentry	SPF-AA SPF-AA	Note 12 Note 12
		(Radio Specialty (Sentry	B J2A	Note 13 Note 13
1	Microphone	Stromberg-Carlson Western Electric	24562 F-1	Notes 11, 16 Note 8
1	Microphone cover grid	Western Electric	P-247808	Notes 8, 11
1	Speaker, 3" magnetic	Premier	M-30	Note 12
1	Speaker, 3" permanent magnet dynamic (in Model AB)	Oxford	30MP	Note 13
1	Headset	Trimm	USFS Type F-100	
1	Cable, microphone-speaker-headset 4-conductor flexible rubber covered	Belden	8454	
1	Plug, microphone-speaker-headset cable	Amphenol	MC4M	
1	Socket, microphone-speaker-headset	"	PC4F	
1	Cable, heavy-duty battery, 5' flexible braid covered. Battery end is fitted with terminals for binding posts and aluminum stamped markings.	Lenz	5-conductor battery cable, per Lenz shop order 89304 mfd for U.S. Dept. Agriculture, Forest Service.	

Note 11: Some sets in group SPF-724 to SPF-743 were supplied with Western Electric Type F-1 microphones and microphone cover grids.

QUANTITY	COMPONENT	MANUFACTURER	TYPE	
1	Cable, light-weight battery, same as heavy-duty battery cable, except length 30".	Lenz	5-conductor battery cable, per Lenz shop order 98304, mfd. for U.S. Dept. Agri., Forest Service	
2	Plugs, battery cable	Jones	Std. 5-prong plug for PM-5C socket with rubber sleeve.	
1	Socket, battery cable	Jones	PM-5C with bevel for 1/16" with nut and bakelite back piece.	
1	Milliammeter, 0-5 ma.	Triplett	221	Note 12
1	Milliammeter, 0-5 ma. supplied with shunt and multipliers (R-301, R-302, R-303).	Simpson	Model 125-S, 0-50 d-c milliammeter with sub-panel assembly spec. 2, 3, 4 revised.	Note 13
1	Jack, key	Utah	ST-531	
9	Sockets. octal bakelite wafer	Cinch	0-15	
1	Socket, 4-prong bakelite wafer	Cinch	X-15	Note 16
1	Socket, 5-prong bakelite wafer	Cinch	Y-15	Note 13
1	Post, binding	X-L	ANT	
4	Shields, tube	Bud	SH-391	
4	Clips, grid	Bud	TC-107	
3	Knobs	Davies	1450, black	

QUANTITY	COMPONENT	MANUFACTURER	TYPE	
1	Knob, meter switch	Mallory	366	
1	Dial	National	BM-2	
1	Cabinet	Radio Specialty	SPF	
1	Kitbox, wooden	" "	SPF	
1	Kit bag, canvas	" "	SPF	
1	Key, telegraph	" "	SPF	Note 14
1	Cord, key	Collyer	Ripcord	Note 14
1	Plug, key	Mallory	75	Note 14
1	Antenna, fixed location (specify crystal frequency when re-ordering)	Radio Specialty	SPF	
1	Halyard, antenna	Connecticut Cordage	Charter Oak Braided Mason Line, Size #4	
1	Antenna, portable, on reel	Radio Specialty	SPF	
1	Halyard, for portable antenna	Connecticut Cordage	Charter Oak Braided Mason Line, Size #3	
1	Book, instructions for operating (specify serial number when re-ordering)	Regional Forester, Portland, Oregon	SPF	

(Page 23 Deleted)

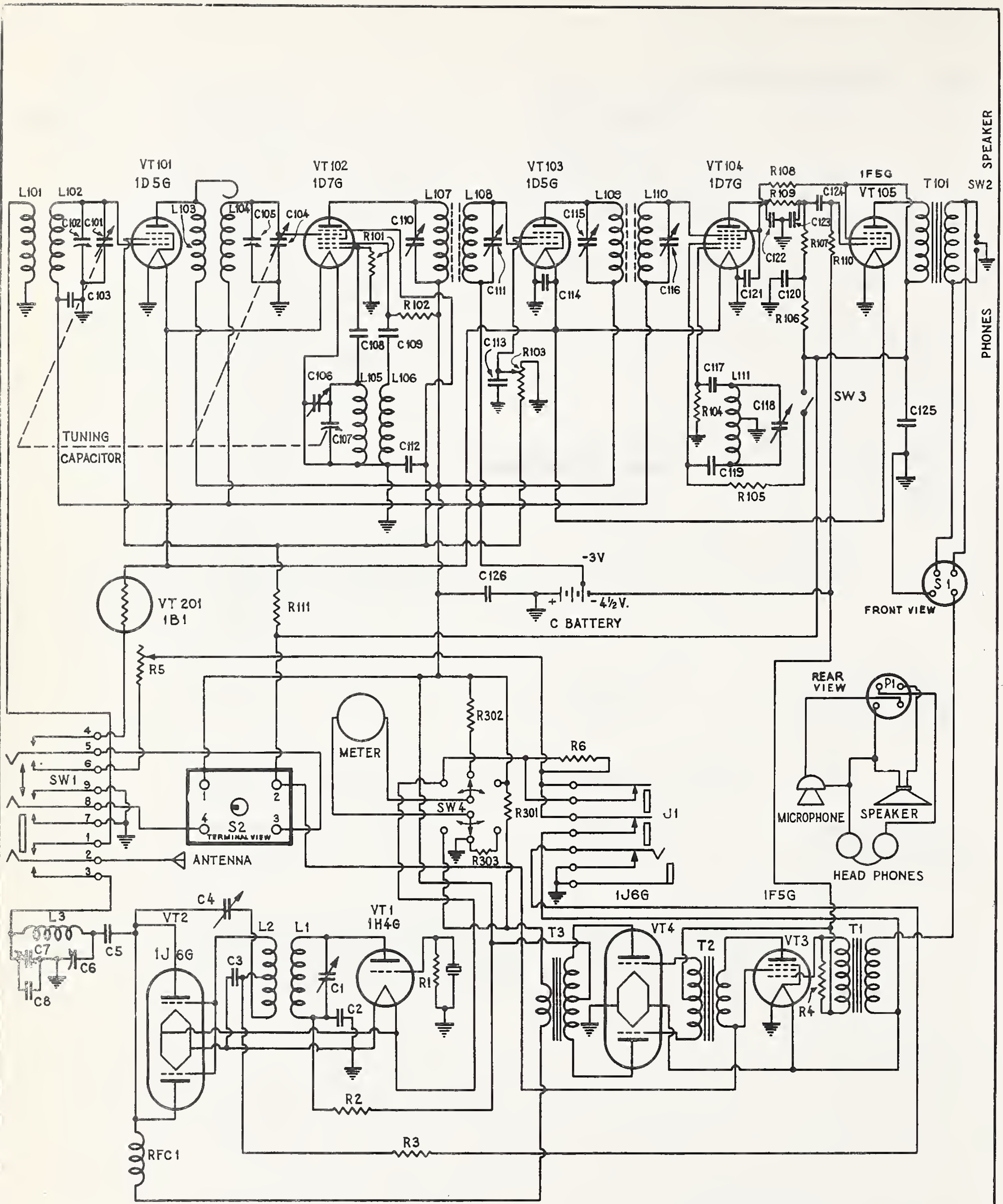
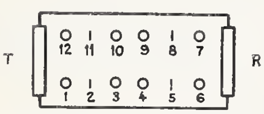


FIG. 2.62



Rear view of switch SW1
Numbers are same as shown
in diagram.

BATTERY CABLE

1. Red = B+180.
2. Green = B+135
3. Brown = A+
4. Blue = B-, Black = A-

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE SPF RADIOPHONE
MODEL AA

DESIGNED & CKD BY E.H.S. APPROVED BY
DRAWN BY D.I.S. DATE JULY 6 1937

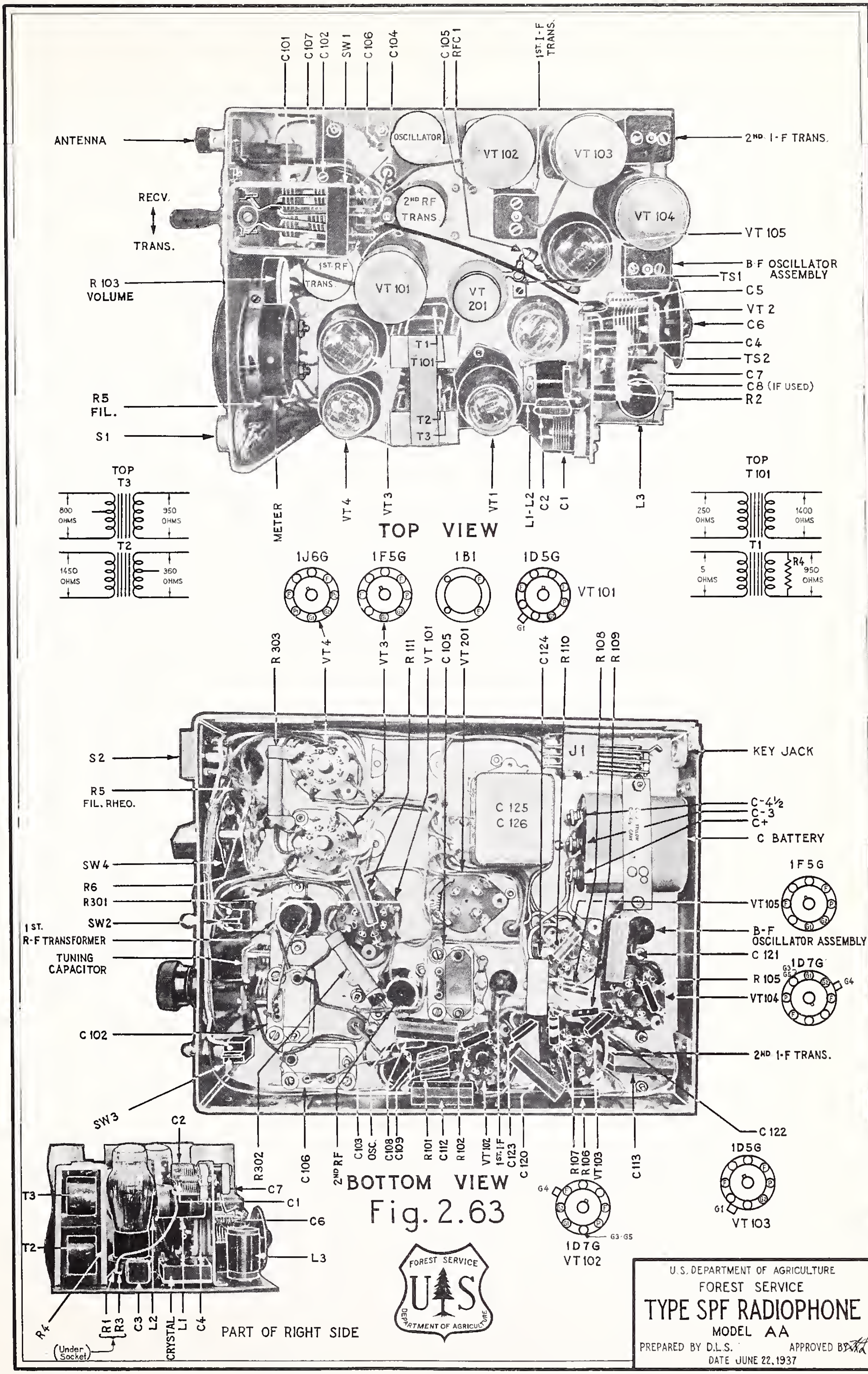

C 101
C 107
C 102
SW 1
C 106
C 104
C 105
RFC 1
1ST. I-F TRANS.
ANTENNA
OSCILLATOR
VT 102
VT 103
2ND. I-F TRANS.
RECV.
TRANS.
2ND RF TRANS
VT 104
VT 105
B-F OSCILLATOR ASSEMBLY
TS1
1ST. RF TRANS.
VT 101
VT 201
R 103 VOLUME
C5
VT 2
C6
C4
T1
T101
TS2
C7
C8 (IF USED)
R2
R5 FIL.
T2
T3
S1
METER
VT 4
VT 3
VT 1
L1-L2
C2
C1
L3
TOP T3
800 OHMS
950 OHMS
T2
1450 OHMS
360 OHMS
TOP T101
250 OHMS
1400 OHMS
T1
5 OHMS
R4
950 OHMS
TOP VIEW
1J6G
1F5G
1B1
1D5G
VT 101
R 303
VT 4
VT 3
R 111
VT 101
C 105
VT 201
C 124
R 110
R 108
R 109
S2
J1
KEY JACK
R5 FIL. RHEO.
C 125
C 126
C-4½
C-3
C+
C BATTERY
SW4
R6
R301
SW2
1ST. R-F TRANSFORMER
TUNING CAPACITOR
1F5G
VT105
B-F OSCILLATOR ASSEMBLY
C 121
R 105
1D7G
VT104
C 102
2ND 1-F TRANS.
SW3
C 122
C2
R302
C 106
2ND RF
C103
OSC.
C108
C109
R101
C112
R102
VT102
1ST. I-F
C123
C 120
R 107
R 106
VT 103
C113
1D5G
T3
C7
C1
C6
T2
L3
BOTTOM VIEW
1D7G
VT 102
VT 103
FOREST SERVICE
DEPARTMENT OF AGRICULTURE
R4
R1
R3
C3
L2
CRYSTAL
L1
C4
PART OF RIGHT SIDE
(Under Socket)
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE SPF RADIOPHONE
MODEL AA
PREPARED BY D.L.S.
APPROVED BY
DATE JUNE 22, 1937

Fig. 2.63

2.71 Modernization to Utilize Low-Drain Receiver Tubes

The modernization embraced in the Type SPF radiophone, Model AD, can be applied to Models AA and AB (serial numbers 265 to 743, inclusive). The improvement is of such value, both economically and technically, that all users of this type of equipment should make every effort to take advantage of the suggested change.

The modernization referred to consists of replacing present tubes in the receiver with newly-available low-drain tubes. The revised receiver will consume approximately one-half the current, both "A" and "B", required by the present set. Reducing the current by one-half far more than doubles the service life of the dry batteries. In addition to the economic gain, the revised receiver provides approximately double the sensitivity of the present set.

The Type SPF radiophone in normal service seldom transmits longer than 1 or 2 minutes at a time, while it may be required to stand by and receive for many hours each day. Consequently any reduction than can be made in receiver battery consumption is very desirable. It is estimated that the saving in dry batteries on a set used through a single fire season in western forests will pay for the cost of the conversion with a possible additional cash saving.

The method of change is relatively simple and can be accomplished by any technician capable of servicing the present equipment. In order that the job may be completed in the simplest and most workmanlike manner the Radio Laboratory has offered to make a sample conversion for each Region, to be used as a guide in converting the remaining sets. Those Regions not equipped to do their own work may prefer to return the radiophones to Portland where they can be altered by one of the local manufacturers.

The schematic diagram for the revised radiophone is included in the Service Data Sheets for Type SPF Radiophone, Model AD.

C13.1 Service Data Sheets

Type SPF

Model AB

Nos. 481 to 743 Inc.

C13.1 Type SPF Radiophone, Model AB

The 1938 Type SPF Radiophones, serial numbers from 481 up, have some changes from the Model AA, described in the foregoing. The following changes were made in the Model AB:

Speaker and microphone housing was altered mechanically.

A 3" permanent magnet dynamic speaker is provided in place of the 3" magnetic speaker. New speaker is Oxford-Tartak Type 3AMP.

Audio output transformer (T101) is different. See 2.5, Parts List for Model AA.

Speaker-phones switch SW2 is DPDT in place of SPDT. See schematic diagram included on following page.

Volume control circuit is different. In the Model AB, screen voltages of both r-f and i-f amplifiers, VT-101 and VT-103, are controlled. R111A, 40,000 ohms, 1 watt, is connected in series between plus B and R103, the volume control. R111, screen-dropping resistor for the mixer, is 15,000 ohms in the Model AB, instead of 12,000 ohms.

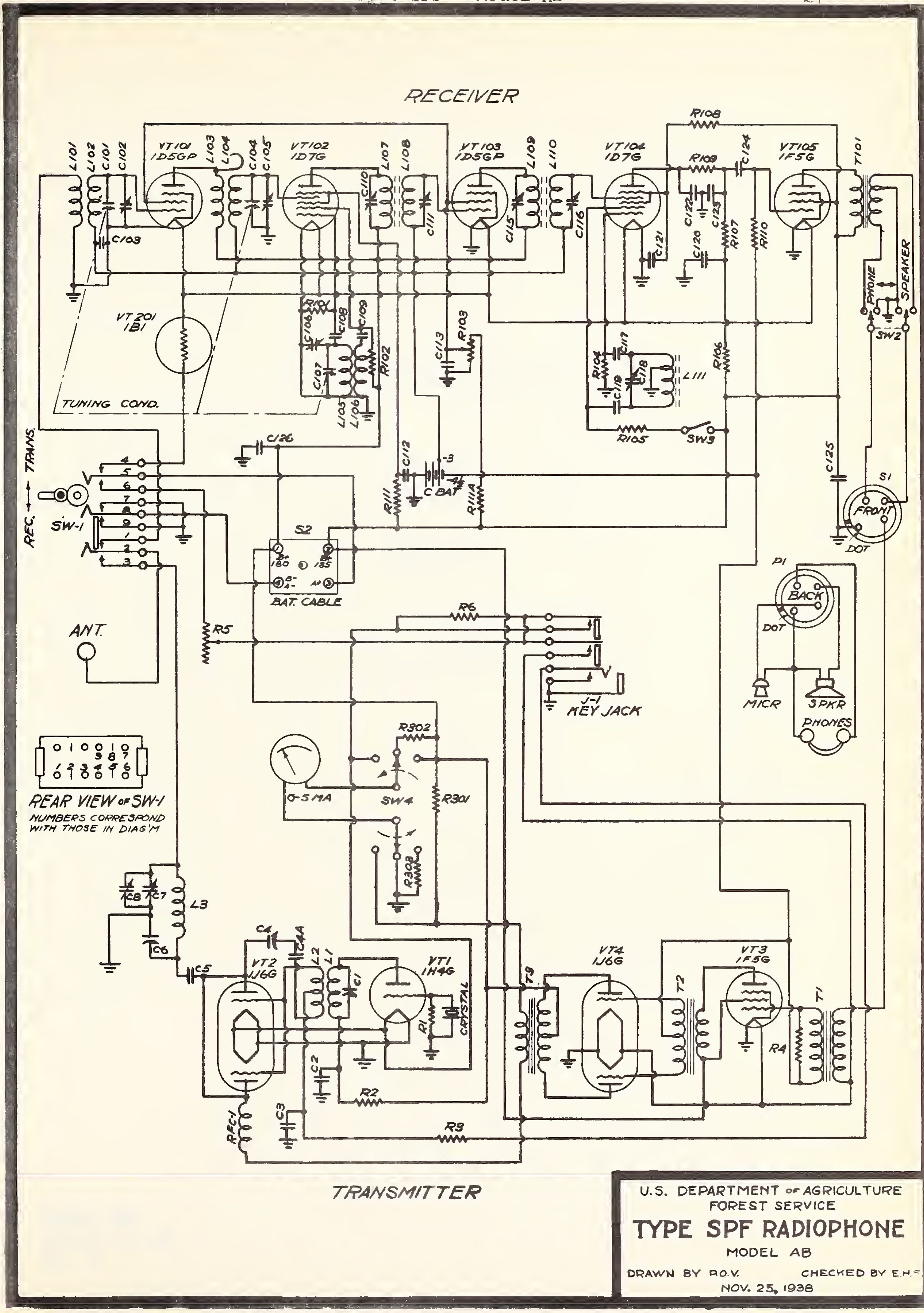
In the Model AB plate voltage on the detector has been increased by changing R109 from 25,000 ohms to 10,000 ohms.

In the Model AB, the loading capacitors, C7 and C8 are Hammarlund Type QTD-250, the single unit embracing both capacitors.

In Model AB, a 500 mmf blocking capacitor C4A has been connected in series with the neutralizing capacitor, C4, on the coil side.

In the Model AB a plug-in type crystal holder has been substituted for the previous type, which was screwed to the chassis.

In the Model AB the panel-meter shunt and multipliers are supplied on a sub-panel assembly by the meter manufacturer.



U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE SPF RADIOPHONE

MODEL AB

DRAWN BY R.O.V. CHECKED BY E.H.S.

NOV. 25, 1938

C13.1 Service Data Sheets

Type SPF

Model AD

Nos. 744 to 903 Inc.

Radio Hbk
Added 4-1-40
No. 6

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0.0 General Description

The Type SPF radiophone, Model AD, is a modernization of the Type SPF, Model AB, in which the newly-available low-drain tubes are substituted in the receiver section. This change results in an exceptionally worthwhile reduction in receiver battery drain, as well as substantial improvement in sensitivity. The Type SPF radiophone in normal service seldom transmits longer than 1 or 2 minutes at a time, while it is frequently required to stand by and receive for many hours each day. Consequently the reduction in receiver battery consumption is very desirable.

The above modernization may be applied to older Type SPF radiophones, Models AA and AB (serial numbers 265 to 743, inclusive). See Sec. C13.1, "Type SPF Radiophone, Model AA", Item 2.71.

1.0 Detailed Description

With the exception of the new receiver tubes and associated wiring of filament and grid-bias-supply circuits, the Model AD is similar to Model AB. See Fig. 2.62, Schematic Diagram for Model AD.

1.3 Power Supply Circuit

Battery voltages and battery types are identical with those in the Model AB. Transmitter power-supply circuits and battery drains are the same as those in the Model AB.

The receiver uses four 1.4-volt tubes and one 3-volt tube. Filaments of pairs of the 1.4-volt tubes are connected in series across the 3-volt "A" battery. The ballast tube has been eliminated.

Proper grid bias is obtained for r-f amplifier, converter, and i-f amplifier tubes by connecting grid returns to the negative sides of the respective filaments. Additional grid bias is applied to the second detector by utilizing the drop across the r-f amplifier filament. Audio amplifier grid bias is supplied from the $4\frac{1}{2}$-volt "C" battery. The 3-volt tap on the "C" battery is not used on this model.

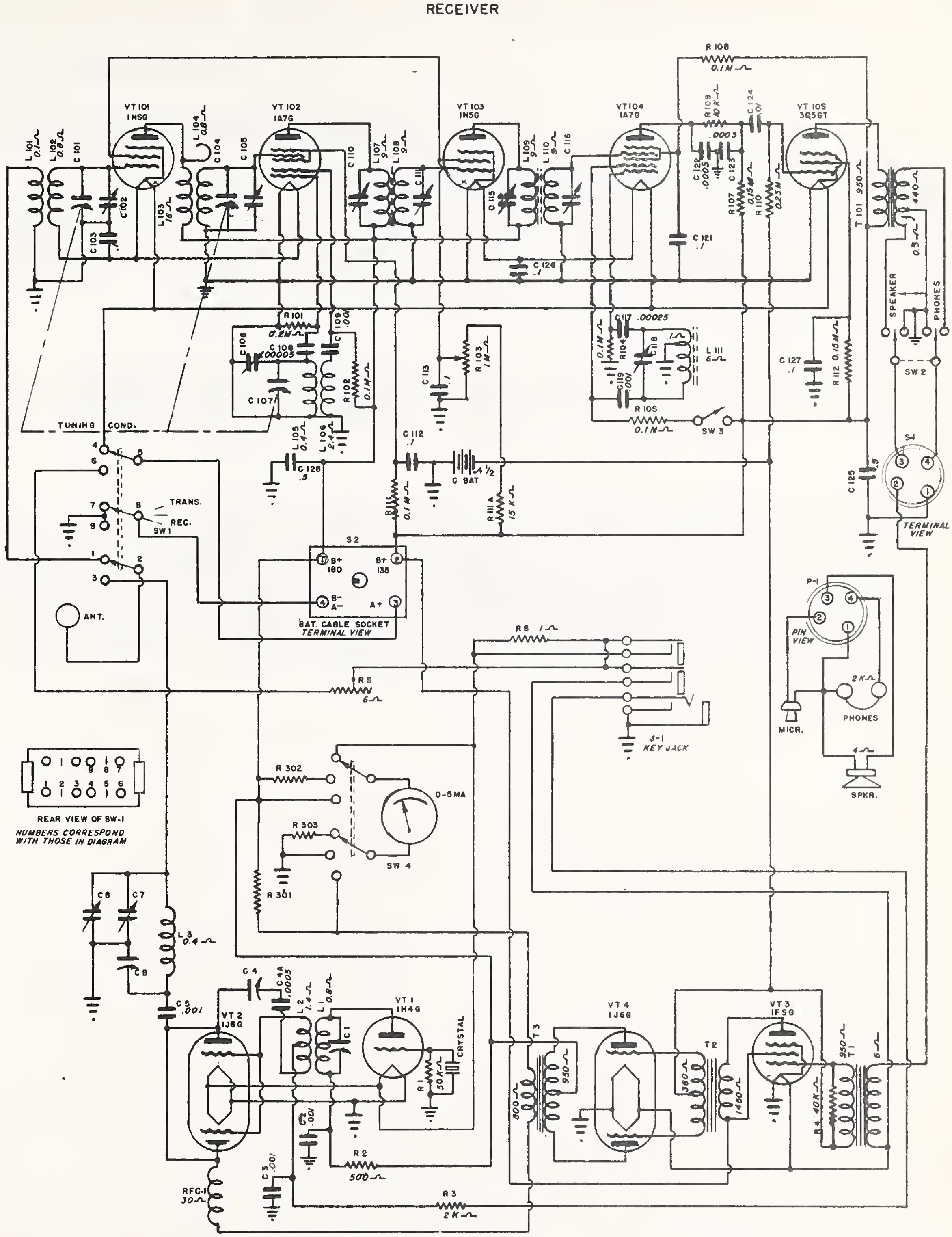
Receiver battery drains are as follows:

Battery	Drain
"A"	150 ma
"B" 135-v	6.5
"B" 180-v	8.

2.5 Parts List

The following table lists components which differ from corresponding parts in the Model AB:

Symbol	Component	Rating	Manufacturer	Type
C-120	Detector Plate Return Bypass Capacitor	Deleted		
C-127	A-F Amplifier Screen Bypass Capacitor	.1 mfd 400-v paper	Solar	MP-4147A
C-128	2nd Detector Filament Bypass Capacitor	.1 mfd.400-v paper	Solar	MP-4147A
R-101	H-F Oscillator Grid Leak	0.2 megohm,½ watt	IRC	BT-½
R-102	H-F Oscillator Anode Grid Dropping Resistor	0.1 megohm,½ "	IRC	BT-½
R-106	Detector Plate Filter	Deleted		
R-107	Detector Plate Load	0.15 megohm,½ watt	IRC	BT-½
R-111	Converter Screen Dropping Resistor	0.1 megohm,½ "	IRC	BT-½
R-111A	Screen Dropping Resistor	15,000 ohms, ½ "	IRC	BT-½
R-112	A-F Amplifier Screen Dropping Resistor	0.15 megohm, ½ "	IRC	BT-½
VT-101	R-F Amplifier		Sylvania,RCA	1N5G
VT-102	Converter		" "	1A7G
VT-103	I-F Amplifier		" "	1N5G
VT-104	Detector and B-F Oscillator		" "	1A7G
VT-105	A-F Amplifier		" "	3Q5GT
	Microphone		Western Electric	F-1
	Microphone cover grid - Western Electric - Type 247808 phenol fibre grid			
	Case, Microphone		Special	



TRANSMITTER

FIG. 2.62

Note:
Ω = OHM
K Ω = 1000 OHMS
M Ω = MEGOHMS

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE SPF RADIOPHONE
MODEL AD

DRAWN BY G.B.C.
CHECKED BY E.H.S.
DATE APR. 22, 1940

USFS RADIO LAB. DRWG
SPF-AD-21-B

FORM RL 3

2.7 ADDITIONAL DATA

2.71 Filament Bypass Capacitor

A .1 mfd. 400 volt paper capacitor (Solar Type MP-4147) has been added between the +3-volt terminal on VT-105 socket (type 3Q5GT tube) and ground. The new part is designated C-129. The addition of this component effectively attenuates excessive b-f oscillator harmonics in the receiver.

This change was made on the following groups of radiophones:

SPF-826 to SPF-835 incl.

SPF-850 to SPF-863 incl.

SPF-866 and higher.

This additional capacitor may be advantageously added to Type SPF, Model AD, radiophones in which it is not already furnished. This, of course, also applies to older models which have been converted to the Model AD. A convenient place for installation is in the area adjacent to the "C" battery, between terminal #7 on VT-105 socket and the ground lug at the base of the post supporting the "C"-battery clamp.

C13.1 Service Data Sheets

Type SPF

Model AE

Nos. 904 to 966 Inc.

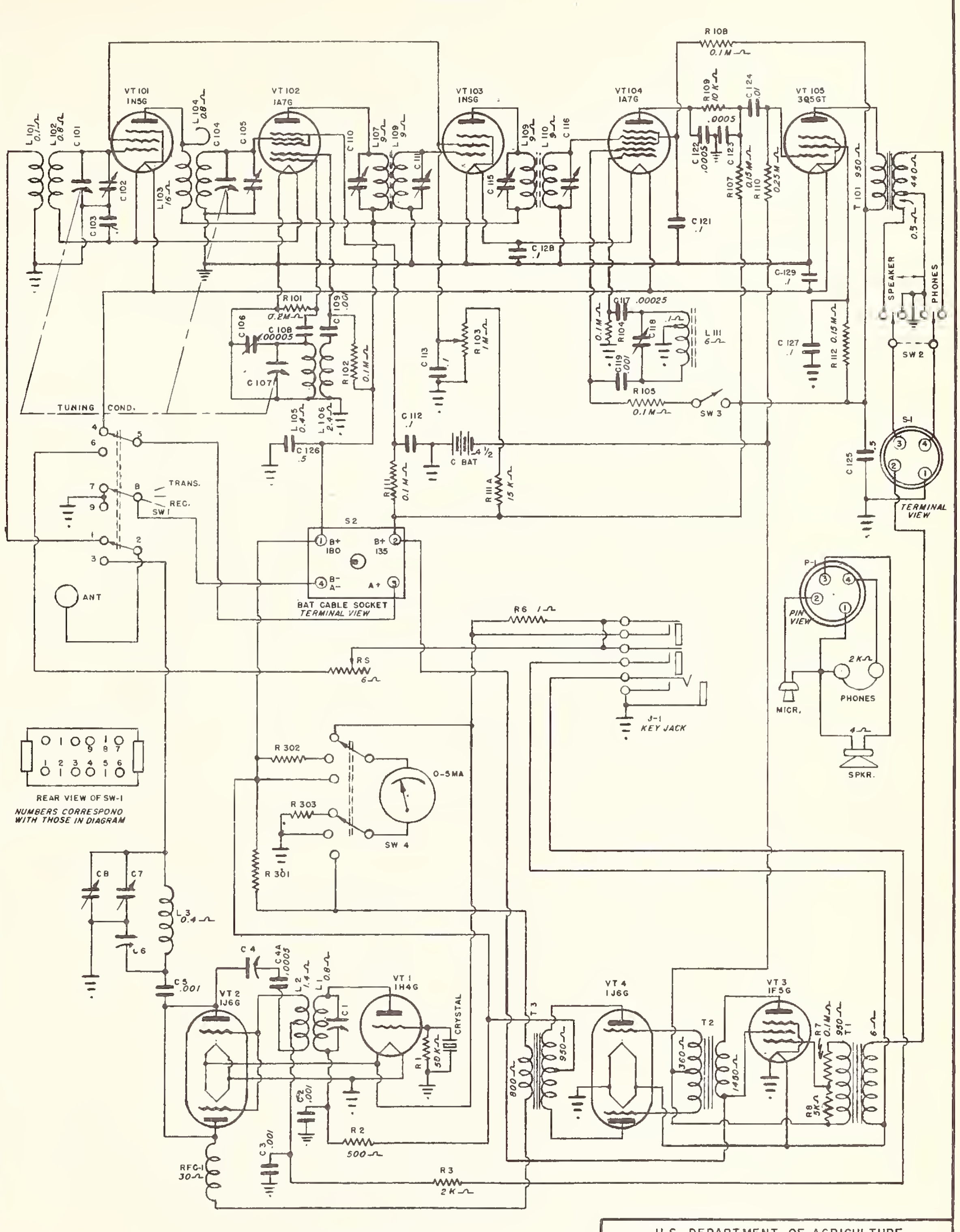
Radio Hdbk.
Added 6-10-41
No. 9

Type SPF Radiophone, Model AE

The Model AE differs from the previous Model AD in details of mounting the microphone and speaker. In the Model AE the microphone may be unsnapped from its support and pulled out approximately 2 feet, permitting more convenient operation in many cases.

*The fact that the Model AE permits bringing the microphone closer to the operator's lips results in increased microphone output. This necessitates a reduction in audio gain to prevent overmodulation. The reduction is accomplished by replacing resistor R-4 across the secondary of microphone transformer T-1, with a voltage divider consisting of R-7 (0.1 megohm) in series with R-8 (5000 ohms). The voltage across the 5000-ohm R-8 is applied to the grid of speech-amplifier VT-3.

RECEIVER



TRANSMITTER

Note:
Ω = OHM
K Ω = 1000 OHMS
M Ω = MEGOHMS

FIG. 2.62

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE SPF RADIOPHONE

MODEL AE

REVISED 9-1-41
REVISED 10-31-40

DRAWN BY G.B.C. CHECKED BY E.H.S. DATE APR. 22, 1940	USFS RADIO LAB. DRWG SPF-AE-21-B

C13.1 Service Data Sheets

Type SPF

Model AF

Nos. 967 to __________ Inc.

Radio Hdbk.
Added 9-25-42
No. 11

TYPE SPF Radiophone, Model AF

Type SPF, Model AE, radiophone has been changed in minor detail in the speech and modulator circuits.

In the interest of conserving time and materials to produce new drawings kindly add the following items to drawing section C13.1, page 34, Radio Handbook, with notation that these changes appear on SPF, model AF.

1. Change R8, speech amplifier input divider, from 5,000 ohms to 10,000 ohms.
2. Add R9, load ~~register on~~ resistor 15,000 ohms across secondary of driver transformer connected from grid to grid of modulator tube ~~VT4, 15,000 ohms.~~ VT-4

C13.2 Service Data Sheets

Type M

Model	B	Nos.	97	to	152	Inc.
Model	C	Nos.	154	to	180	Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.

Note: For operating information see "Instructions for Operating," furnished with radio set.

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1.4 Switching Circuits

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2.3 Power Supply Data

2.4 Switching Circuit Data

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2.6 Diagrams

*2.7 Additional Data

*2.71 Power Supply Revision

0.0 General Description

The Type M Radiophone transmits voice modulated or cw telegraph signals over a rated distance of approximately 50 miles in the frequency range 2900 to 3500 kilocycles. Power is supplied from a commercial 110-120 volt, 60-cycle line or portable gasoline driven generator. The frequency is maintained constant at its assigned value by means of a quartz crystal in the oscillator circuit. A half-wave antenna is used with a single wire feeder. The microphone furnished is equipped with a push-button switch to actuate the relay which makes the necessary circuit changes from receive to transmit.

The receiver furnished is of commercial design and covers the entire range of Forest Service frequencies in this band, as well as others.

Both transmitter and receiver are housed in a metal case, the transmitter being located on the upper shelf with the receiver below. A compartment is also provided below the receiver to house the accessories, such as key, headphones, antenna, etc.

0.1 Electrical Specifications

Power supply	110-120 volt, 60-cycle a.c.
Frequency	2952 to 3445 kilocycles
Frequency control	Crystal
Power output	20 watts
Working range	Approximately 50 miles
Antenna	Half-wave, single wire feeder
Tubes, transmitter	Type 41 oscillator Type RK-20 r-f amplifier Type 41 modulator Type RK-19 rectifier
Tubes, receiver	See manufacturer's data
Output of receiver	See manufacturer's data
Input to transmitter	Microphone or key
Type of transmission	Voice or cw telegraph

0.2 Physical Specifications

Approximate overall dimensions

Height	24 inches
Width	22 inches
Depth	14 inches
Weight, packed for transport	250 pounds

PART 1

1.0 Detailed Description

The transmitter and its power supply are located on a single chassis which fits into the steel cabinet above the receiver. All connections except the antenna are made with plug-in connectors, polarized as necessary to prevent errors. Parts may be identified from the Parts List (2.5), the Schematic Diagram (2.62), and the Photodiagram (2.63).

1.1 Transmitter Circuit

The transmitter consists of an r-f section with the crystal-controlled oscillator and a final amplifier, an a-f section with a microphone amplifier-modulator, and a power supply unit to furnish proper voltages and currents to the entire transmitter.

The oscillator circuit is controlled by a quartz crystal ground to the proper thickness to vibrate at the frequency assigned to the transmitter. The voltage developed across this crystal is fed to the grid of oscillator VT1 to which bias voltage is furnished through the flow of grid current through resistor R1. The plate of VT1 works into the tuned circuit consisting of inductor L1 and capacitor C1, and screen current is fed through resistor R2 bypassed by capacitor C2. A portion of the voltage across this tank circuit is picked up by a tap on the coil and fed through capacitor C3 to the grid of the final amplifier, VT2. Bias for this stage is developed by grid current flowing through choke RFC1 and resistor R3. The filament is bypassed by capacitors C4 and C5. Screen voltage is furnished from a tap on the voltage divider and the screen is bypassed by capacitor C6. The plate of the final r-f amplifier feeds into the final tank (and antenna matching network) through coupling capacitor C7. The final tank is resonated by capacitor C8, and capacitor C9 serves to load the antenna and match it to the tube impedance. Plate voltage to the final stage is supplied through choke RFC2 and a 0-100 m.a. meter indicates final plate current.

Suppressor grid modulation is used and modulation voltage is fed from the secondary of the modulation transformer through RFC3, with capacitor C10 to bypass radio frequency.

Voltage for the single-button carbon microphone is supplied from a section of the voltage divider and is bypassed by the low-voltage capacitor C11. The variations of microphone current are fed through the primary of input transformer T1 and the induced voltage from its secondary is applied to the grid of the modulator tube, VT3. This tube is supplied with grid-bias voltage through the drop in resistor R4 due to the cathode current flowing through it. C12 bypasses the cathode. The plate and screen of VT3 are connected to opposite ends of the primary of modulation transformer T2, with the screen connected to the supply voltage and bypassed by capacitor C13. The secondary of this transformer is loaded with resistor R5, and feeds the suppressor of the final r-f amplifier as noted above.

1.2 Receiver Circuit

The receiver furnished with this radiophone is of commercial design, and manufacturer's data should be consulted for information concerning it.

1.3 Power Supply Circuit

The cathodes of all tubes are heated by current from the filament transformer T202. Plate voltage is supplied to the rectifier, VT201, by the plate transformer, T201, whose center tap goes to the negative end of the voltage divider. The pulsating output of the rectifier is smoothed by a filter consisting of swinging choke L201 and smoothing choke L202, and capacitors C201 and C202.

The voltage divider is connected across the entire output of the filter and consists of R206 (at the positive end), R205, R204, R203, R202, and R201 (at the negative end). The plate of VT2 is supplied with the highest positive voltage; its screen is supplied from the junction of resistors R206 and R205 with about 305 volts; the plate and screen of VT3 are supplied from the junction of R205 and R204, and the microphone voltage is taken from the junction of R204 and R203. The junction of R203 and R202 is grounded to the chassis and a negative potential of about 40 volts is applied to the suppressor of VT2 through the key jack (J-1) and the secondary of the modulation transformer from the junction of resistors R202 and R201. The other end of R201 is connected to the negative end of the power supply, and applies about 150 volts negative to the suppressor grid of VT2 when the key plug is inserted in the key jack and the key is in the up position. Capacitor C203 bypasses that portion of the voltage divider which is negative with respect to ground.

A fuse is provided in series with the line.

1.4 Switching Circuits

Switching from transmit to receive is effected by means of a relay, controlled by a push button on the microphone (SW2). The normal position of the relay connects the antenna to the receiver, closes the receiver plate circuit and opens the primary of the plate transformer of the transmitter power supply (T201). When its coil is actuated, the relay connects the antenna to the transmitter, opens the receiver plate circuit, and closes the primary of T202. The coil of the relay is operated by voltage from the 6.3 volt filament winding of T202.

Switch SW1 disconnects the transmitter from the line.

In addition to applying a negative voltage to the suppressor grid of the final amplifier, the key jack (J-1) also shorts the secondary of the modulation transformer.

PART 2

2.0 Adjustment and Repair

Tools and Equipment

(a) Usual complement of bench and hand tools for servicing.

(b) High resistance voltmeter--1000 ohms or more per volt. 0-10 volts, 0-250 volts, and 0-1000 volts full scale.

(c) Milliammeter 0-10 m.a.

(d) Ohmmeter.

(e) Cathode-ray oscilloscope.

(f) Coupling device for oscilloscope.

(g) Dummy load. 25-watt, 120-volt lamp as dummy load for antenna.

General Procedure

(a) Check tubes.

(b) Inspect for open circuits and obvious failures of parts.

(c) See that all contacts are clean and making proper connection.

(d) If set still fails to operate properly, make a detailed check of the circuit in accordance with the following data: the Schematic Diagram (2.62), the Photodiagram (2.63), and the Parts List (2.5).

2.1 Transmitter Data

Proceed according to the following schedule.

1. Remove transmitter from cabinet.

(a) Remove screws from front panel.

(b) Slide transmitter forward.

(c) Disconnect speaker plug, "B" leads of receiver, and antenna of receiver.

(d) Place transmitter on bench, with under side accessible.

2. Open grid circuit of final amplifier below r-f choke or bias resistor and insert 0-10 m.a. meter to indicate grid current.

3. Attach dummy load between antenna post and frame of set.

4. Connect power plug to line and turn on set.

Caution: Certain exposed leads inside the transmitter carry in excess of 1000 volts and are definitely dangerous.

5. Adjust capacitor C1 (oscillator plate tuning) to give maximum indication on grid meter.

6. Adjust capacitor C8 ("R" on panel) for minimum plate current as indicated by meter on panel.

7. Adjust capacitor C9 ("L" on panel) until plate meter reads about 40 m.a.

8. Re-adjust capacitor C8 ("R") for minimum plate current.

9. Again adjust C1 until maximum grid current is indicated.

10. Check modulation with oscilloscope. (Couple pick-up coil to final amplifier tank circuit.)

11. If set is now operating properly, remove meter from grid circuit and restore transmitter to cabinet.

2.2 Receiver Data

Since the receiver furnished with this equipment is of commercial design, service information for the receiver will be found in the manufacturer's data.

2.3 Power Supply Data

The high voltage of this power supply is about 1200 volts d-c under load, which is definitely dangerous; every precaution against shock should be taken in making measurements with the power on.

In case trouble is suspected in the power supply, test all components for continuity, grounds, and short-circuits before turning on the power.

The rectifier tube should be checked to see that a plate-to-cathode short-circuit has not occurred. Such a fault causes heating of the plate transformer and usually shows as a flash or arc inside the tube if the power is applied.

The normal resistances of the various components are indicated in Fig. 2.63.

2.4 Switching Circuit Data

Burning of contacts or noisy contacts should be cared for by cleaning contact points and adjusting relay spring tension. See 1.4 for descriptive material on operation.

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Oscillator plate	50 mmf	Hammarlund	MC50S
C2	Oscillator screen bypass	.005 mf	Solar	MW-1239
C3	Final grid coupling	.0001 mf	Solar	MW-1216
C4	Final cathode bypass	.005 mf	Aerovox	1456
C5	Final cathode bypass	.005 mf	Aerovox	1456
C6	Final screen bypass	.005 mf	Aerovox	1456
C7	Final plate blocking	.001 mf	Aerovox	1457
C8	Final plate resonating	100 mmf	Cardwell	MT-100-GS
C9	Antenna loading	260 mmf	Cardwell	MR-260-BS
C10	Suppressor bypass	.002 mf	Aerovox	1461
C11	Microphone voltage bypass	25 mf	Aerovox	PR100
C12	Modulator cathode bypass	25 mf	Aerovox	PR100
C13	Modulator plate bypass	8 mf	Girard-Hopkins	C8
C14	Oscillator plate bypass	.003 mf	Solar	MW-1235
C15	Oscillator filament bypass	.002 mf	Solar	MW-1233
C201	First rectifier filter	2 mf	Cornell-Dubilier	TD15020
C202	Second rectifier filter	4 mf	Cornell-Dubilier	TD15040
C203	Bias voltage bypass	8 mf	Girard-Hopkins	C8

2.52 Inductors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L1	Oscillator plate (56 turns #20 enamel on $1\frac{1}{2}$ inch form)			
L2	Final amplifier plate (41 turns #16 enamel on 2-inch form)			
*L201	Swinging filter	40-8 henries	(Inca (Thordarson	D40) T8402)
*L202	Smoothing filter	20 henries	(Inca (Thordarson	D5) T8403)
RFC1	Final amplifier grid	---	National	100
RFC2	Final amplifier plate	---	Hammarlund	CH500
RFC3	Final suppressor	---	National	100
RFC4	Final screen	---	National	100

*Transformers and filter chokes may be either Inca or Thordarson, depending upon the particular set involved. In ordering these replacements, please include manufacturer's name and type number of part.

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R1	Oscillator grid	30,000 ohms	IRC	BT1
R2	Oscillator screen	20,000 "	IRC	BT1
R3	Final grid	15,000 "	Ward-Leonard	507-208
R4	Modulator cathode	500 "	Ward-Leonard	507-334
R5	Modulation transformer loading	10,000 "	IRC	BT1
R201	Keying bias	1,500 "	Ward-Leonard	507-194
R202	Suppressor bias	300 "	Ward-Leonard	507-244
R203	Microphone voltage	300 "	Ward-Leonard	507-244

2.53 Resistors (cont.)

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R204	Modulator plate voltage	12,000 ohms	Ward-Leonard	507-207
R205	Final screen voltage	5,000 "	Ward-Leonard	507-175
R206	Final plate voltage	10,000 "	Ward-Leonard	507-273

Resistors R201 to R206, inclusive, make up the voltage divider.

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT1	Crystal oscillator	RCA, Sylvania	41
VT2	Final amplifier	Raytheon	RK-20
VT3	Speech amplifier - modulator	RCA, Sylvania	41
VT201	Rectifier	Raytheon	RK-19

2.55 *Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T1	Microphone	(Inca (Thordarson	03689)
T2	Modulation	(Inca (Thordarson	L13) T6778)
T201	Rectifier plate	(Inca (Thordarson	3605) T8400)
T202	Filament	(Inca (Thordarson	3606) T8401)

*Transformers and filter chokes may be either Inca or Thordarson, depending on the particular set involved. In ordering these replacements, please include manufacturer's name and type number of part.

2.56 Switches

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
SW1	Main power	DPST	H & H	21-ST
SW2	Microphone	SPST		In microphone handle

2.59 Miscellaneous

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
	Relay		Leach	2123MX
J1	Key jack		Mallory	705A
	Pin jack, 2 required		Mallory	416
	Antenna post		X-L	ANT
	Meter	0-100 ma	Westinghouse	MX
	Sockets - 6-prong, 1 required		Eby	8C
	6-prong, 1 required		Hammarlund	S-6
	5-prong, 1 required		Hammarlund	S-5
	4-prong, 1 required		Hammarlund	S-4
	Fuse clip		Littelfuse	1060
	Crystal	Special	Radio Specialty Co.	
	Crystal holder	Special	Radio Specialty Co.	
	Loudspeaker for receiver		Wright DeCoster	258
	Loudspeaker cord and plug	Four-conductor cord with four-prong plug		
	Main power cord	Standard Tyrex cord with plug		

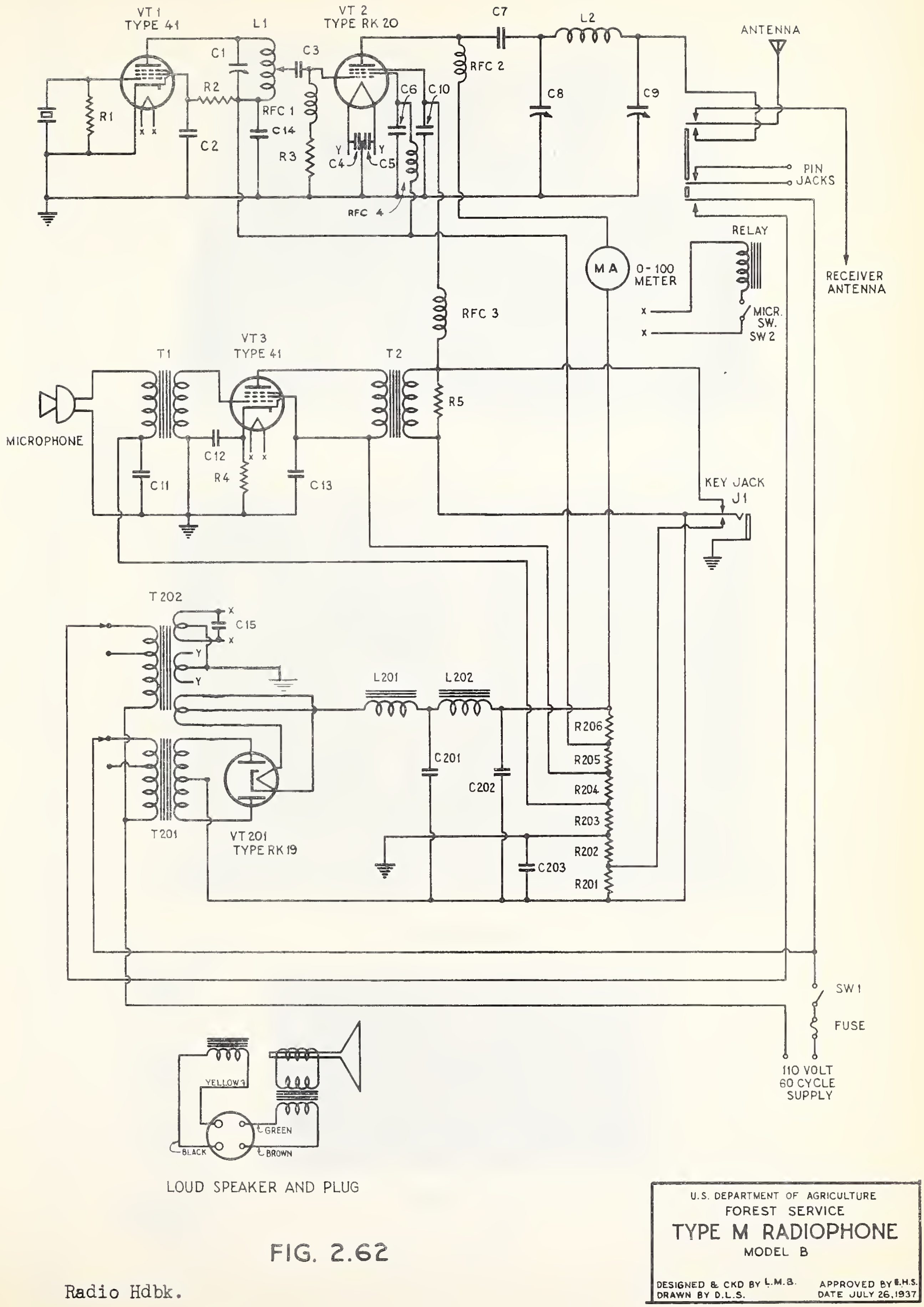
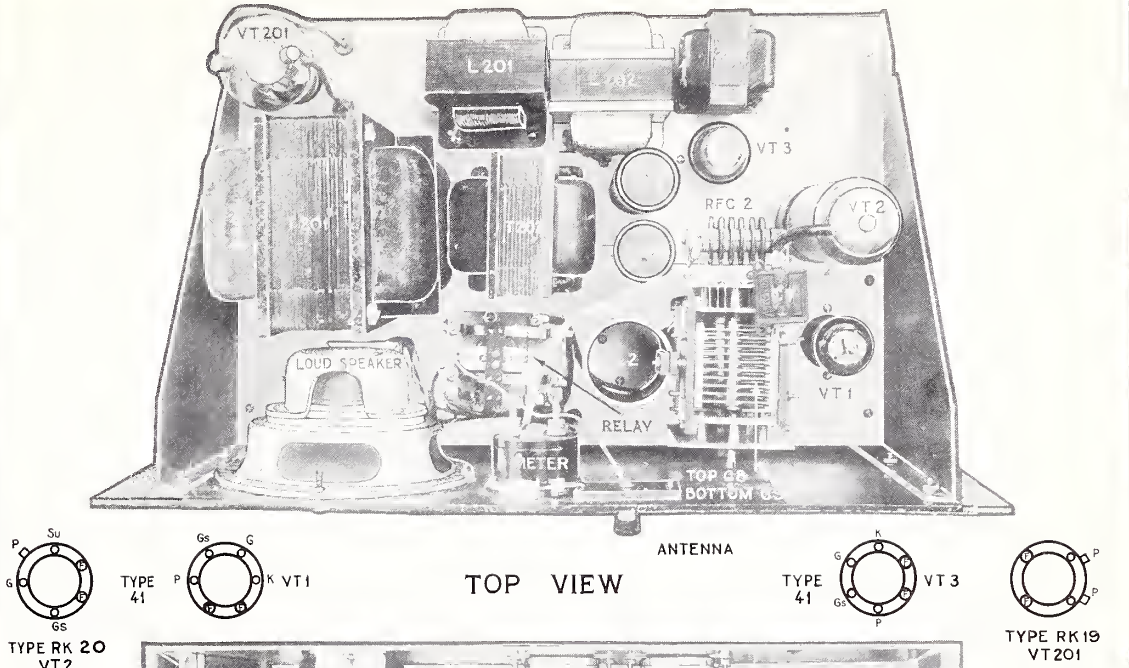
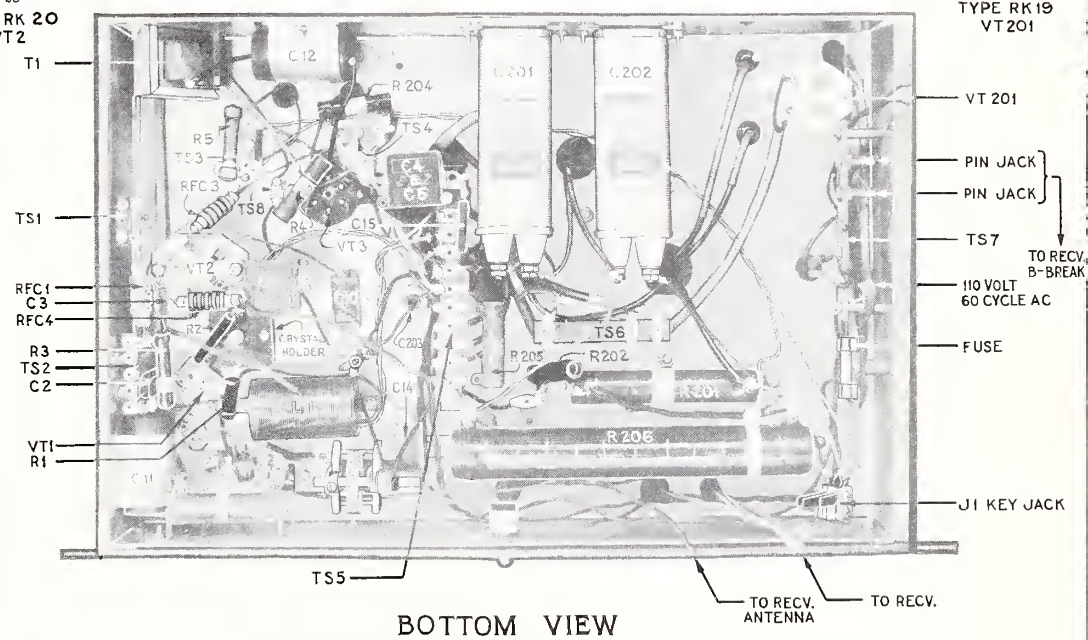

VT 1
TYPE 41
L 1
VT 2
TYPE RK 20
C7
L2
ANTENNA
C1
C3
RFC 2
R2
R1
C6
C10
C8
C9
RFC 1
C14
C2
R3
C4
C5
PIN
JACKS
RFC 4
RELAY
MA
0-100
METER
RECEIVER
ANTENNA
RFC 3
MICR.
SW.
SW 2
VT 3
TYPE 41
T1
T2
R5
MICROPHONE
C12
R4
C11
C13
KEY JACK
J1
T 202
C15
L201
L202
R206
R205
R204
R203
R202
R201
C201
C202
C203
T201
VT 201
TYPE RK 19
SW 1
FUSE
110 VOLT
60 CYCLE
SUPPLY
YELLOW
GREEN
BLACK
BROWN
LOUD SPEAKER AND PLUG
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE M RADIOPHONE
MODEL B
DESIGNED & CKD BY L.M.B.
DRAWN BY D.L.S.
APPROVED BY E.H.S.
DATE JULY 26, 1937

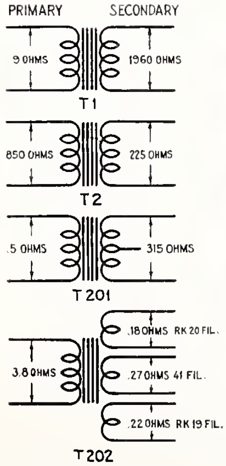
FIG. 2.62

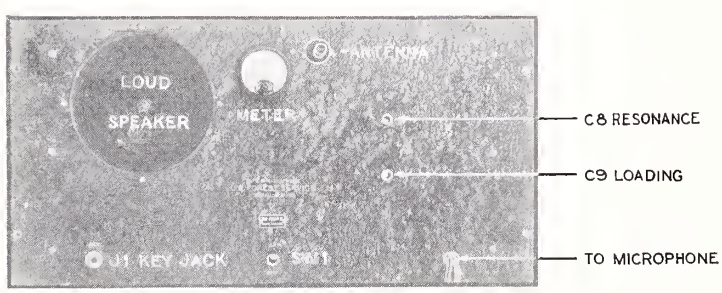


TOP VIEW



BOTTOM VIEW





FRONT VIEW

Fig. 2.63

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE M RADIOPHONE
MODEL B
PREPARED BY D.L.S. APPROVED BY E.H.S.
AUG. 12, 1937

2.7 Additional Data

2.71 Power Supply Revision

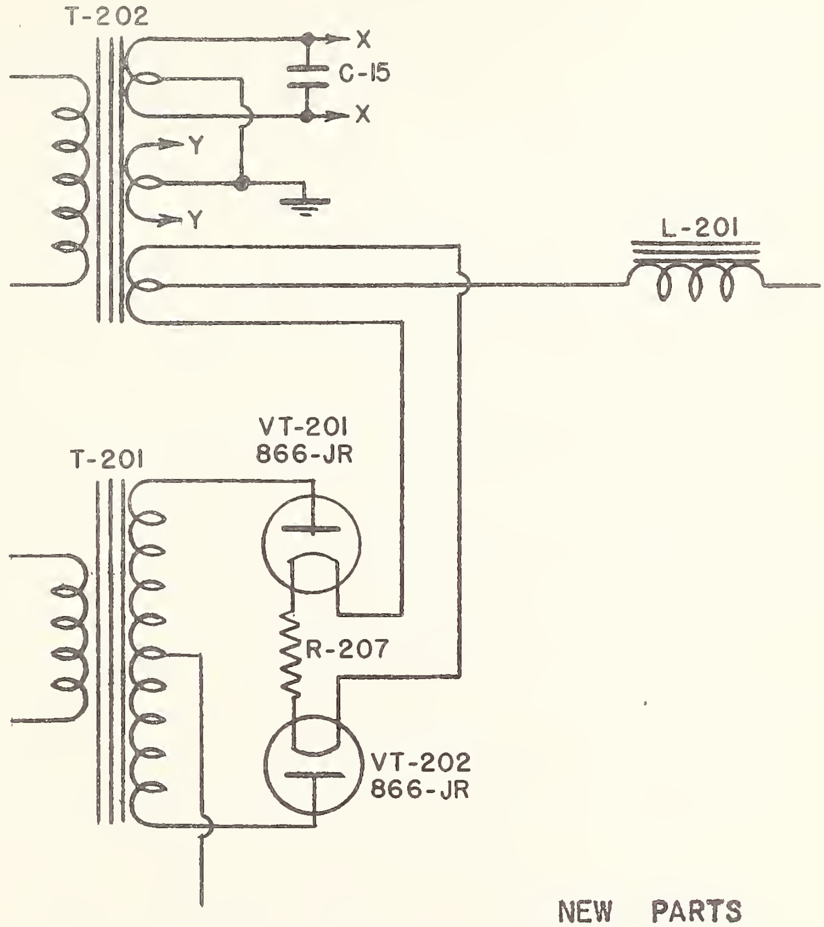
The Type RK-19 rectifier tube, formerly manufactured by Raytheon Products Corp., is no longer being supplied, and no direct substitute is available. Circuit changes are described below which will permit the use of currently available rectifier tubes.

Experience has shown the undesirability of selecting a tube type available only from a single manufacturer. However, in this case such a selection permits the necessary changes to be made without the addition of a new filament transformer, which is desirable in view of the advanced age of the Type M, Model B Radiophone.

The recommended substitution for the single Type RK-19 is a pair of Taylor Type 866-Jr tubes. Individual filament ratings are 2.5 volts, 2.5 amperes. It will of course be necessary to install a new socket for the second rectifier tube. It is suggested that the two filaments be connected in series with each other, and with a 1-ohm 10-watt resistor, such as the Ohmite "Brown Devil". This series circuit may then be connected across the existing 7.5-volt rectifier-filament winding of transformer T-202 (See Fig. 2.62, Schematic Diagram). A schematic diagram showing the suggested change is shown on Fig. 2.71.

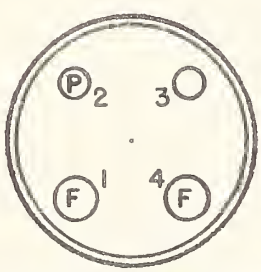
The manufacturer of the Type 866-Jr tubes recommended is Taylor Tubes, Inc., 2341 Wabansia Avenue, Chicago.

Another manufacturer, the Hytron Corporation, also supplies a Type 866-Jr tubes, but this product is not interchangeable with that listed above. Filament current is higher, and the plate terminal is a cap at the top of the tube, instead of a socket terminal.



NEW PARTS

VT-201	TAYLOR TYPE 866-JR
VT-202	TAYLOR TYPE 866-JR
R-207	OHMITE "BROWN DEVIL" 1-OHM, 10-WATTS



SOCKET CONNECTIONS
TYPE 866-JR
BOTTOM VIEW

FIG 2.71

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE M RADIOPHONE, MODEL B
REVISION NO. 1

DRAWN BY E.H.S. CHECKED BY H.K.L.
JAN. 15, 1940

USFS RADIO LAB DRWG M-B-22-A

C13.3 Service Data Sheets

Type M

Model C Nos. 154 to 180 Inc.

Model D Nos. 181 to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Note: For operating information see "Instructions for Operating," furnished with radio set.

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1.3 Power Supply Circuit

1.4 Switching Circuits

PART 2

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2.3 Power Supply Data

2.4 Switching Circuit Data

2.5 Parts List

2.6 Diagrams

0.0 General Description

The Type M Radiophone transmits voice or cw telegraph signals over a rated distance of approximately 50 miles in the frequency range 2900 to 3500 kilocycles. The set may be operated on 110-120 volts a.c. only. The receiver furnished is of commercial design and covers the same range of frequencies, with others in addition. The transmitter frequency is maintained constant at its assigned value by means of a quartz crystal in the oscillator circuit. A half-wave type antenna is used and is fed with a single wire transmission line. Pressing a switch button on the microphone actuates the relay which makes the necessary circuit changes from receive to transmit. When a separate antenna is used on the receiver the set may be operated duplex ("break-in") fashion.

A carrying case designed to serve as a field desk houses the entire equipment for shipping and includes detachable legs, internal power connections for the receiver, desk lamp, and shelf for writing surface.

0.1 Electrical Specifications

Power supply	110-120 volt, 60-cycle a-c
Frequency range	2952 to 3445 kilocycles
Frequency control	Crystal
Power output	20 watts
Working range	Approximately 50 miles
Antenna	Half-wave, single wire feeder
Tubes, transmitter	Type 6F6G oscillator Type 6L6G final amplifiers (2 in parallel) Type 6F6G speech amplifier Type 6L6G modulator (2 in push-pull) Type 83 rectifier (2 required) Total - 8
Tubes, receiver	See manufacturer's data
Output of receiver	See manufacturer's data
Input to transmitter	Microphone or key
Type of transmission	Voice or cw telegraph

0.2 Physical Specifications

Approximate overall dimensions, in carrying case

Height	34 inches
Width	23 "
Depth	$15\frac{1}{2}$ "
Weight packed for transport	220 pounds

Overall dimensions, transmitter and power supply only (approximate)

Height	$16\frac{1}{2}$ inches
Width	$19\frac{1}{2}$ "
Depth	$12\frac{1}{4}$ "

PART 1

1.0 Detailed Description

The radio transmitter and its power supply are on separate bases which fit, one above the other, in the steel cabinet comprising the radiophone. All connections except antenna are made with plug-in connectors, polarized as necessary to prevent errors. Parts may be identified from 2.5, the Parts List, 2.62, the Schematic Diagram, and 2.63, the Photodiagram.

1.1 Transmitter Circuit

The transmitter comprises an r-f section consisting of the crystal controlled oscillator (VT1) and a final amplifier with VT2 and VT3 in parallel; an a-f section consisting of speech amplifier VT4 and a modulator with VT5 and VT6 in push-pull; and a power supply unit to furnish proper voltages for operating the entire transmitter.

The oscillator circuit is controlled by a quartz crystal ground to the proper thickness to vibrate at the frequency assigned to the transmitter. The voltage developed across this crystal is fed to the grids of VT1, to which bias voltage is supplied through RFC1. This bias voltage is developed by the plate current of the oscillator flowing through resistor R1 from cathode to ground. This resistor is bypassed by capacitor C1, which also introduces a slight amount of regeneration. RFC2 confines the r-f to its proper path and prevents its appearance at jack J1. Plate voltage is supplied to the oscillator through isolating resistor R2 (bypassed by C3) and the coil L1, which is tuned by capacitor C2.

The grids of the final amplifier (VT2 and VT3) are excited in parallel from coil L2, bias being furnished by the voltage drop in resistor R3, bypassed by capacitor C5 and by cathode resistor R4 bypassed by C17. Resistors R5 and R6 prevent parasitic oscillations and neutralizing is effected by capacitor C4. Plate voltage for the final amplifier is fed through r-f choke RFC3. The r-f voltage is developed in the final tank coil L3, which is tuned by capacitors C8, C9, and C10. The latter two also serve to change the antenna loading.

The varying current from the microphone is fed into the primary of a-f transformer T1, through whose secondary a varying voltage is applied to the grid of the a-f driver tube, VT4. Resistors R8 and R9 act as a fixed gain control to set the overall level and are adjusted as necessary to take care of the microphone characteristics. Bias voltage is developed by the flow of plate current through resistor R10, bypassed by capacitor C12. The plate current of the driver tube is fed through the primary of transformer T2 and its variations induce a varying voltage in the secondary which is applied to the grids of the modulator tubes, VT5 and VT6 in push-pull. The secondary is loaded with resistors R11 and R12. Biasing voltage for the modulator tubes is furnished by the cathode current passing through resistor R13. Plate voltage is applied to the modulators through transformer T3, whose secondary carries the plate current of the final r-f amplifier and effects modulation by the Heising system. Plug P2 connects to power supply socket S2 and properly allocates the various voltages of the latter.

The microphone cable contains four wires, two for the microphone current and two for the "push-to-talk" switch (SW4) which operates the send-receive relay. These wires are connected to plug P1 which connects with socket S1 in the transmitter. The loudspeaker for the receiver is also mounted on the panel adjacent to the a-f and r-f deck and connected to the receiver through Socket S3.

1.2 Receiver Circuit

The receivers furnished with this series of M sets are of commercial design, and information for operating and servicing them will be found in the manufacturer's instruction manual. Power for the receiver may be obtained from the connection in the cabinet or from a suitable outlet on the desk or other location where the receiver is installed. The same antenna is switched from the transmitter to the receiver by the relay in the transmitter.

The loudspeaker for the receiver is located in the upper portion of the transmitter chassis and is connected to it with plug P3. This plug also places a pair of relay contacts in series with the

B-plus lead of the receiver, so that the plate voltage is removed from the receiver tubes when the transmitter is on. The loudspeaker leads themselves plug into pin jack J6 in the upper deck of the transmitter as shown on the connection diagram.

1.3 Power Supply Circuit

The power supply section comprises a filament transformer T5, a plate transformer T4, rectifier tubes, VT7 and VT8, filter inductors, filter capacitors, and voltage divider.

The filaments of the two rectifiers are separately heated from two of the windings on the filament transformer T5, and the third winding supplies the heaters of the tubes in the transmitter. Three taps are provided on both transformers for changes in line voltage from 105 to 125 volts, with the factory connection on the 115-volt tap. The plate voltage is applied to the rectifiers VT7 and VT8 from secondary of the plate transformer T4. Fuses are connected in one side of the line to each of the transformers for protection in case of overload. Each rectifier feeds into a separate filter inductor (CH1 and CH2) which join at the connection to the filter capacitors (C15 and C16) and inductor CH3. The resistors R16, R15, and R14 comprise a voltage divider to supply microphone voltage, screen voltage for modulators, and plate and screen voltage for speech amplifier.

A pilot light is connected across the main filament winding with a voltage reducing resistor R17 in series.

1.4 Switching Circuits

Besides the switches in various parts of the circuit, switching is performed by the send-receive relay. This has SPDT contacts to switch antenna from receiver to transmitter, SPST contacts to close the primary of the plate transformer and so apply voltage to the plates of the transmitting tubes, and SPST contacts to open the B-plus circuit of the receiver and render it inoperative during periods of transmission. The contacts are arranged in the above order, from the front to the rear of the transmitter chassis.

The switch (SW1) marked "BREAK-IN" "NORMAL" on the front panel is a double pole double throw toggle and serves the following purpose in the two positions - "BREAK-IN" in effect closes receiver plate supply contacts of relay and places oscillator cathode return in parallel with final r-f amplifier cathode return, thus allowing oscillator to be keyed together with final. "NORMAL" position removes the short on the receiver

relay contacts and puts oscillator cathode return direct to the ground, thus allowing the oscillator to operate constantly on cw with the final amplifier only being keyed.

Switch SW2 is connected in parallel with SW4 and both operate to energize the relay for the send position.

Switch SW3 is the main-line switch and disconnects the entire transmitter from the line when in the "off" position.

2.0 Adjustment and Repair, General

Tools and Equipment

(a) Usual complement of bench tools

(b) High resistance d-c voltmeter (0-10, 0-250, 0-1000 volts, 1000 ohms per volt)

(c) A-c voltmeter (0-10, 0-250, 0-1000 volts full scale)

(d) D-c milliammeters (0-10 and 0-250 ma full scale)

(e) Ohmmeter

(f) Cathode-ray oscilloscope

(g) R-f pick-up circuit for oscilloscope

(h) Dummy load as substitute for antenna

General Procedure

In case the transmitter fails to operate, check the following items:

(a) Line voltage at set (105v to 125v)

(b) Fuses in set

(c) Tubes (for emission and shorts or opens)

(d) Relay contacts

(e) Voltages as in part designated "Transmitter" (below)

A detailed analysis may be made, if necessary, with the assistance of the Schematic Diagram and the Photodiagram.

2.1 Transmitter Data

In case it is necessary to change the frequency of an M set, the following procedure may be used. The same routine may be followed for a check-up of the tuning adjustments, without changing the crystal itself (omit items 5 and 6).

1. Remove rear panel from transmitter.

2. Remove screws holding antenna post.

3. Disconnect meter and speaker from pin jacks on deck.

4. Remove upper deck from cabinet, leaving power cable connected, and reconnect plate meter, making a temporary extension for the leads.

Note: Frequency may be checked and adjustments made without removing transmitter from cabinet, but it is done more easily as noted above.

5. Loosen nuts on crystal holder and connecting lead and remove crystal holder.

6. Install new crystal holder with crystal in place and tighten nuts and connecting lead.

7. Plug key in key-jack J7 and see that switch SW1 is in "NORMAL" position. Leave key open as it is desired to keep final amplifier from operating.

8. Plug meter with full-scale reading of 60 or more milliamperes into jack J1 marked "OSC."

9. Plug meter with full-scale reading of 10 milliamperes or more into jack marked "FINAL GRID."

10. Place main switch SW3 in "ON" position.

11. Place switch SW2 in up position to "TRANS. CW."

12. The oscillator only should now be in operation, with the cathode circuit of the final stage held open by the key.

13. Starting with the plates of capacitor C2 fully meshed, which should give a reading of 1 to 4 milliamperes on the meter used in item 8 above, gradually open the plates of C2 until the crystal begins to oscillate. This will be evident by a current of about 20 milliamperes on the meter. The plates should now be further opened until about 35 milliamperes flow in the plate circuit.

14. If the crystal does not start to oscillate until the oscillator plate current reaches a value of 50 or more milliamperes, the crystal is inactive, defective, or needs cleaning. In some cases a sluggish crystal will oscillate freely after starting but will refuse to start with a normal value of plate current. For this reason it is imperative that the capacitor adjustment be made by opening the plates, and never by turning them toward the closed position.

15. The next step is the neutralization of the final stage. The telegraph key is left open, so that plate current does not flow in the final stage. Using the rectifier-wavemeter connection, resonate the USFS Type A Test Meter to transmitter frequency by coupling its coil to oscillator coil L1, and adjusting dial for maximum Test Meter deflection. Coupling should not be closer than necessary to produce a meter indication.

With Test Meter tuning undisturbed, couple Test Meter coil to final tank coil, L3. Resonate final tank circuit by varying C8. Resonance will be indicated by maximum current in Type A Test Meter. Coupling between L3 and Test Meter coil should be adjusted so that this maximum current is somewhat above mid-scale.

Vary C4 for minimum or zero Test Meter current.

An alternate method of neutralizing, making use of the oscilloscope, is stated in paragraphs 16 to 19, inclusive.

*16. Couple the pick-up circuit of the oscilloscope loosely to the plate coil of the oscillator (L1) and adjust for maximum deflection of the oscilloscope pattern. (This is only to tune oscilloscope pickup.) Couple the pick-up circuit of the oscilloscope to the final tank coil of the output stage (L3).

17. Disconnect the antenna or other loading from the final tank circuit.

---

*If neither the Type A Test Set nor oscilloscope is avilable, use method indicated in Item 23 to check neutralization. The plate voltage must be applied to the final stage and the transmitter placed in operation for such a check.

18. With key still open, tune the final circuit to resonance, as indicated by the maximum deflection on oscilloscope.

19. Loosen the locking nut on the neutralizing capacitor C4 and adjust this capacitor for minimum deflection on the oscilloscope. This should be attained with the plates about one-half meshed.

20. Use a 25-watt, 120-volt lamp for a dummy load and connect it from antenna to ground (panel of set).

21. Close key to start final amplifier. With final amplifier in resonance, the grid current should be from 4 to 5 ma. Normal grid current with final under load should be approximately 3.5 ma.

22. Adjust the loading and resonance according to instruction sheet furnished with set, or as follows. Adjust resonating capacitor C8 until set meter reads the minimum value. If this reading is below the "NORMAL" (green area on meter) capacitor C9 should be adjusted until the meter rises to the "NORMAL" position and the resonating capacitor again adjusted for minimum plate current. This procedure should be continued until the meter indicates in the green area and the resonance capacitor has been adjusted last for minimum plate current.

23. Test accuracy of neutralization by seeing that maximum grid current and minimum plate current occur at the same setting of the resonance capacitor C8.

24. Recheck oscillator plate current to see that it is 35 milliamperes or slightly more and that maximum grid current is being obtained in the final amplifier.

25. Check modulation. This is done best by observing the pattern on the oscilloscope screen. Correct modulation may also be checked roughly by observing a considerable increase in the brilliancy of the lamp used for dummy load when speaking into the microphone. A third method is to listen in with a receiver. For this test care must be used to see that the receiver is not overloaded by receiving too much signal from the transmitter, which would cause distortion to take place in the receiver. The cathode-ray oscilloscope is the only simple way to measure the percentage modulation.

The following are average values for the quantities listed:

Line voltage	115 volts	a-c
Rectifier filament volts	5.1 "	"
Heater volts	6.2 "	"
Final plate voltage	420 "	d-c
Audio driver plate voltage	290 "	"
Audio driver plate current	40 milliamperes	"
Oscillator plate current	35 "	"
Modulator plate current	100 "	"
Final plate current	100 "	"
Final grid current	3.3 to 4.0 "	"
Voltage across each half of plate transformer	510 volts	a-c

Transformer Resistances (d-c)

Transformer	Primary ohms	Secondary ohms
T1	2.0	3200
T2	500	220
T3	135	65
T4	1.0	64
T5	5.1	0.15
T6	525	–

Inductors

Ch1, Ch2	120
Ch3	345
Relay coil	1.3

Additional Data

Filter capacitors: The power supply filter capacitors in these sets are connected in series. Care must be taken if any work is done on the capacitors that the lug on C16 does not cut through the grommet and come in contact with the chassis. This would short out one capacitor, and while the voltage rating of the capacitors is adequate, it would eliminate the safety factor in this part of the circuit.

Antenna connection: Be sure to remove the two screws which hold the antenna post insulating plate in place before attempting to remove the audio and r-f deck from the cabinet.

Microphone cord: There will normally be a drop of from 1.2 to 1.5 volts in the cord between SW4 and S4 during operation; with abnormally low line voltage SW4 may not operate the relay while SW2 will do so.

Poor reception: In some cases the receiver may not operate properly because the relay fails to connect the antenna to the receiver. The remedy is to clean the relay contacts and check the spring tension. Too much spring tension will make the relay slow or inoperative with microphone pushbutton; too little tension will cause poor contact in the receive position.

Antenna loading: In shifting to the lower Forest Service frequencies, it may be necessary in some cases to add more capacitance to padder C10. This added capacitor will be about .0001 mf and should have 2500 volt insulation. Receiving type condensers may serve but due to thinner dielectric may be less reliable in operation.

Measuring voltages:	Voltage on final stage--J5 to ground
	Grid bias, final stage--J2 to ground
	Grid bias, oscillator--J1 to ground
	Grid bias, a-f driver--J3 to ground
	Grid bias, modulator--J4 to ground
Measuring currents:	Plate current, final--J5
	Grid current, final--J2
	Cathode current, oscillator--J1
	Cathode current, a-f driver--J3
	Cathode current, modulator--J4

2.3 Power Supply Data

If rectifier tubes are burned out or weak or if there is no d-c voltage on transmitter, check for shorted filter condenser or insulation breakdown in chokes, transformers or wiring (See Part 1, Section 1.3).

Insulation breakdown on the r-f and audio deck may destroy rectifier tubes and produce no voltage or extremely low voltage.

2.4 Switching Circuit Data

Failure of transmitter to start may result from burned out relay, faulty relay contacts, or spring adjustment of relay armature.

Noise in receiver may result from dirt in relay contacts or weak contact pressure.

Remove lid from relay to clean and adjust contacts, taking care not to increase spring tension beyond the point where relay will close readily upon pressing microphone button.

(See Part 1, Section 1.4, for details on relay and other switching.)

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Cathode bypass	250 mmf	Cornell-Dubilier	2W
C2	Oscillator plate tuning	50 mmf	Cardwell	ZR50AS
C3	Oscillator plate bypass	.001 mf	Solar	MH1027
C4	Final amplifier neutralizing	5 mmf	Cardwell	ZV5TS
C5	Final grid bypass	.002 mf	Solar	MW1233
C6	Screen bypass	.002 mf	Cornell-Dubilier	9-12D2
C7	Plate blocking	.002 mf	" "	9-12D2
C8	Final resonating	365 mmf	Cardwell	MR365BS
C9	Antenna loading	365 mmf	"	MR365BS
C10	Antenna loading padder	250 mmf	Cornell-Dubilier	9-25T25
C11	Micr. supply bypass	10 mf	Mallory	BN266
C12	Audio driver cathode	10 mf	Same case with C11	
C13	Modulator screen bypass	8 mf	Aerovox	G6
C14	Modulator cathode	20 mf	Mallory	BN266
C15	Rectifier filter	16 mf	Aerovox	GG5
C16	Rectifier filter	16 mf	"	GG5
C17	Final cathode bypass	.002 mf	Solar	MW1233

2.52 Inductors

SYMBOL	COMPONENT	MANUFACTURER	TYPE
L1	Oscillator plate		
L2	Final amplifier grid		
L3	Final amplifier plate		
CH1	Swinging filter	Thordarson	13C85
CH2	Swinging filter	"	13C85
CH3	Second filter	"	1607
RFC1	Oscillator grid choke	National	R100
RFC2	Oscillator cathode choke	"	R100
RFC3	Amplifier plate choke	"	R100

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R1	Oscillator cathode	500 ohms	Ward-Leonard	507-334
R2	Oscillator plate filter	500 "	" "	507-334
R3	Final amplifier grid	20,000 "	IRC	BT1
R4	Final amplifier cathode	250 "	Ward-Leonard	507-332
R5	Parasitic suppressor	50 "	IRC	BT1
R6	Parasitic suppressor	50 "	IRC	BT1
R7	Amplifier screen	7,500 "	Ward-Leonard	507-411
R8	Gain control	25,000 "	IRC	BT½
R9	Gain control	25,000 "	IRC	BT½
R10	Audio driver cathode	500 "	Ward-Leonard	507-334
R11	Modulator grid loading	5,000 "	IRC	BT1

2.53 Resistors (cont.)

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R12	Modulator grid loading	5,000 ohms	IRC	BT1
R13	Modulator bias	200 "	Ward-Leonard	507-397
R14	Voltage divider	400 "	" "	507-333
R15	Voltage divider	10,000 "	" "	507-202
R16	Voltage divider	1,250 "	" "	507-167
R17	Pilot lamp dropping	20 c.t.	Mallory	810C

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT1	Crystal oscillator	RCA, Sylvania, or equivalent	6F6G
VT2	Final amplifier	" " " "	6L6G
VT3	" "	" " " "	6L6G
VT4	Speech amplifier	" " " "	6F6G
VT5	Modulator	" " " "	6L6G
VT6	"	" " " "	6L6G
VT7	Rectifier	" " " "	83
VT8	"	" " " "	83

2.55 Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T1	Microphone input	Thordarson	T8378
T2	Audio driver	"	T6778
T3	Modulation	"	T10M84
T4	Plate	"	T10P82
T5	Filament	"	T13F86
T6	Output--on speaker	"	

2.56 Switches

SYMBOL	COMPONENT	MANUFACTURER	TYPE
SW1	Break-in	H & H	DPDT toggle
SW2	Carrier	"	SPST "
SW3	Main power	"	SPST "
SW4	Microphone (in microphone)		

2.59 Miscellaneous

SYMBOL	COMPONENT	MANUFACTURER	TYPE
Jacks:			
J1	Oscillator plate current	Mallory	2
J2	Final grid current	"	2
J3	A-f driver plate current	"	2
J4	Modulator plate current	"	2
J5	Final amplifier plate current	"	432
J6	Loud speaker	"	432
J7	Key	"	704B
Sockets:			
S1	Microphone	Jones	S4A
S2	Power deck	"	S8AB
S3	Receiver	Amphenol	S5
S4	Receiver (in receiver)		
S5	AC power for receiver	Standard single convenience outlet	

2.59 Miscellaneous (cont.)

SYMBOL	COMPONENT		MANUFACTURER	TYPE
Plugs:				
P1	Microphone		Jones	P4CCT
P2	Power		"	P8CCT
P3	Receiver		Amphenol	P5
P4	Receiver			
	Relay		Leach	2123MX
	Microphone		Kellogg	FS21C
	Loudspeaker		Wright DeCoster	582
	Meter 0-150 ma.		Westinghouse	Type RX Style 839759
	Fuses	5 amp.	Tungsol	
	Rectifier sockets	2 req.	Amphenol	S4
	a-f and r-f tube sockets	6 req.	"	S8
	Pilot lamp		6-8 v Standard radio type	
	Pilot lamp socket		Miniature	
	Crystal		Radio Specialty Co.	Special
	Crystal holder		" " "	"

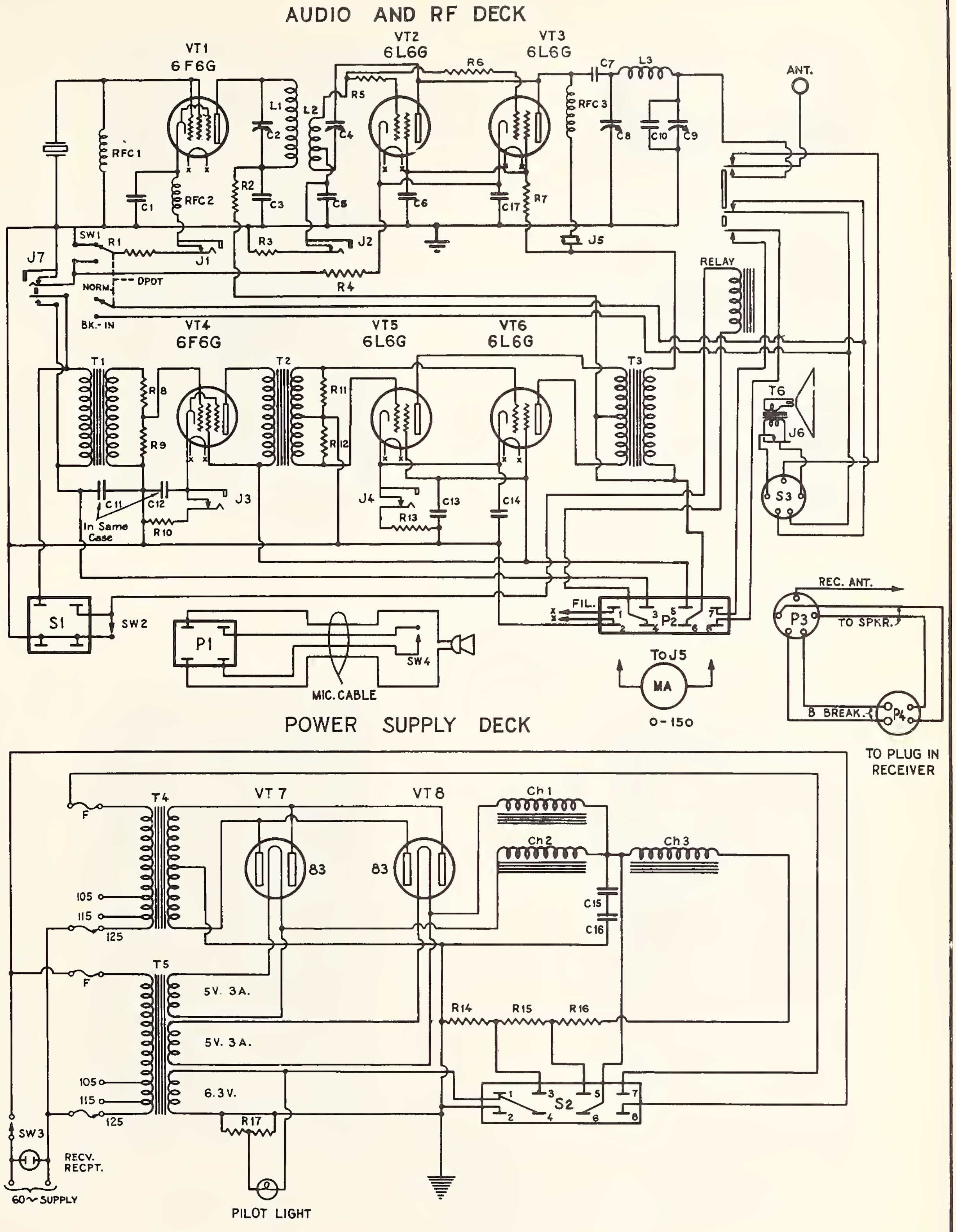

FIG. 2.62

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE M RADIOPHONE
MODEL C

DESIGNED & CKD BY L.M.B. APPROVED BY E.H.S.
DRAWN BY D.L.S. DATE MAY 20 1937

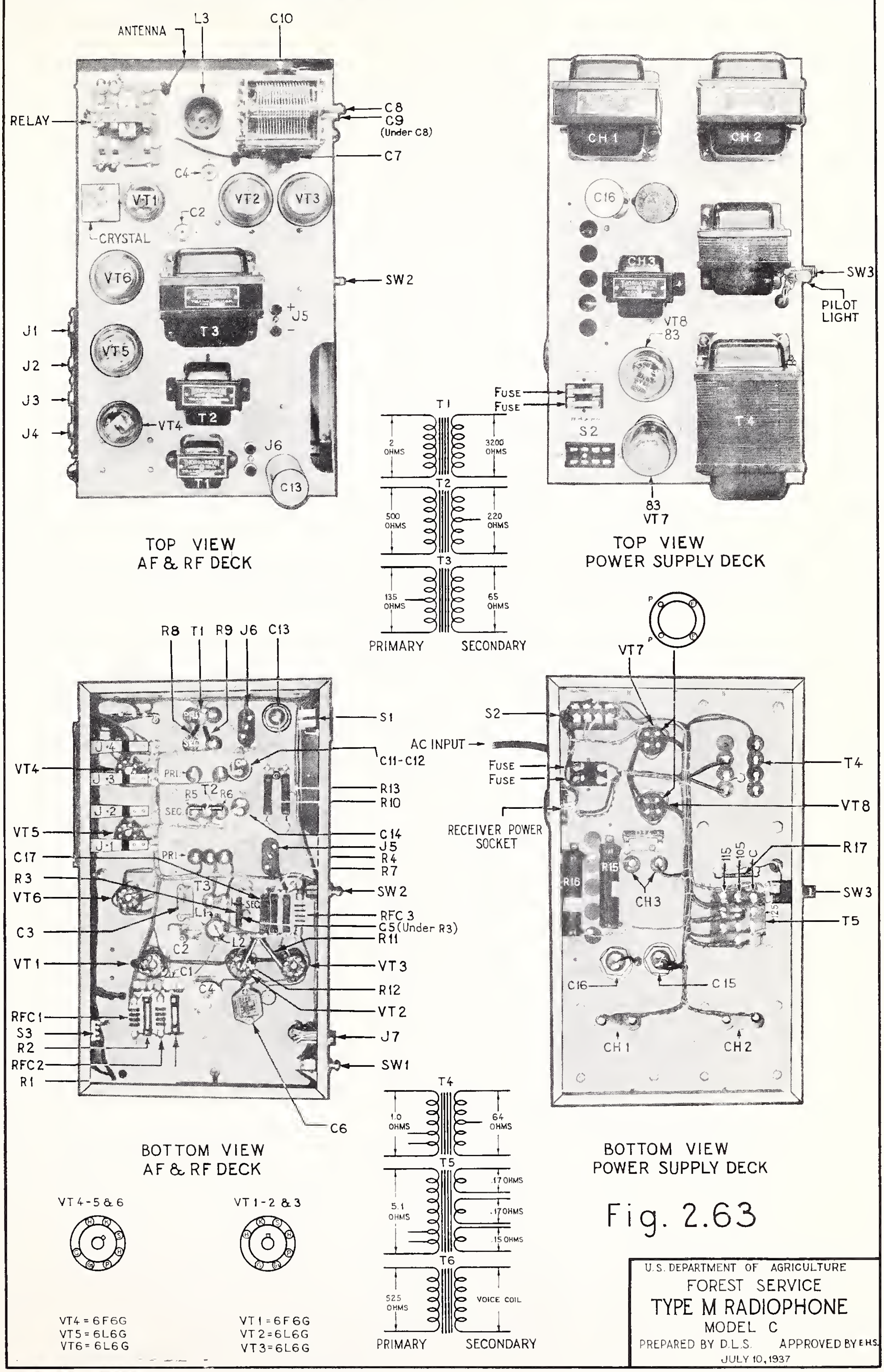

Fig. 2.63

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE M RADIOPHONE
MODEL C
PREPARED BY D.L.S. APPROVED BY E.H.S.
JULY 10, 1937

C13.3 Service Data Sheets

Type M

Model D Nos. 181 to Inc.

Note: For operating information see "Instructions for Operating" furnished with radiophone.

Radio Hbk.
Added 2-1-40
No. 4

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0.0 General Description

The Type M Model D Radiophone is a voice or code transmitter-receiver which operates from 110 to 120 volts a-c 50-60 cycle power. It is intended for communication with the field from supervisor's headquarters and for use as a central communication station on large project fires. Both voice and c-w telegraph operation are provided. The rated transmitting range is 50 miles. The crystal-controlled transmitter operates on one of the frequencies assigned to the Forest Service between 2900 and 3500 kc, and has a rated power output of 20 watts. The microphone has a push-to-talk button for use during voice operation. The receiver is a sensitive superheterodyne which operates in the frequency range 2900 to 3500 kc.

The Radiophone is housed in a rugged sheet-metal case. A wooden shipping case is supplied. A compartment in the shipping case stores antenna, halyards, microphone, headphones, and telegraph key.

0.1 Electrical Specifications

Frequency Range, Transmitter	One specific Forest Service frequency between 2900 and 3500 kc.
Frequency Control	Crystal
Type of Signal	Voice or C.W.
Working Range	Approximately 50 miles.
Power Supply	110-120 volts 50-60 cycle a.c.
Power Output	20 watts
Antenna	Half-wave, fed off center.
Tube Complement, Transmitter	1 Type 6K6G Oscillator 1 Type 807 Final Amplifier 2 Type 6L6G Modulators 1 Type 5Z3 Rectifier
Tube Complement Receiver	1 Type 6K7 R-F Amplifier 1 Type 6A8 Converter 1 Type 6K7 I-F Amplifier 1 Type 6Q7 Detector 1 Type 6K6G A-F Amplifier 1 Type 6K7 B-F Oscillator 1 Type 5W4 Rectifier
Input	Hand Microphone or Telegraph Key
Output	Speaker or Headphones

0.2 Physical Specifications

Radiophone Dimensions, Overall	$12\frac{1}{2}$" wide x $15\frac{1}{2}$" high x $13\frac{1}{2}$" deep.
Shipping Case Dimensions, Overall	15" wide x 20-3/4" high x 14-3/4" deep.
Radiophone Weight, including accessories, but less shipping case.	70 lbs.
Shipping weight	91 lbs.

1.0 Detailed Description

The transmitter and receiver are built on separate chassis, the transmitter chassis occupying the upper half of the cabinet, and the receiver chassis the lower half. Physical arrangement of components is shown in Fig. 2.63, the Photodiagram. Components may be identified by reference to 2.5, Parts List, and Fig. 2.62, the Schematic Diagram.

1.1 Transmitter Circuit

Except for power supply, the transmitter in the Type M, Model D transmitter is electrically identical with that of the Type I, Model D. See Sec. C13.8, Type I, Model D, Item 1.1, "Transmitter Circuit". Corresponding transmitter components in the Type M, Model D and the Type I, Model D have identical symbols, so the Schematic Diagram for the Type M may be used with the above text. The exception to this statement is R-6 in the Type M corresponds with R-13 in the Type I.

1.2 Receiver Circuit

Except for power supply, the receiver in the Type M, Model D is electrically identical with that of the Type I, Model D. See Sec. C13.8, Type I, Model D, Item 1.2, "Receiver Circuit". Corresponding receiver components in the Type M, Model D and the Type I, Model D have identical symbols, so the Schematic Diagram for the Type M may be used with the above text.

1.3 Power Supply Circuit

The transmitter and receiver have separate power supplies. Power Drains are as follows:

Table 1

Power Drains

Receiver only	44 watts
Transmitter filaments only	48 watts
Transmitter operating	175-200 watts (Varies with modulation)

Power factor under all conditions is better than 95%.

1.31 Transmitter Power Supply

Filament transformer T-201 supplies voltage for filaments of tubes and pilot lamp, and for the winding of send-receive relay (Relay-1). A primary series resistor R-205, accessible under the transmitter chassis, is adjusted at the factory so that 6.3 volts will be applied to heaters of radio tubes when line voltage is 117 volts. The technician may adjust R-205 to compensate for abnormally high or low line voltage.

Plate power is provided by a standard full-wave tube-rectifier circuit with a 2-stage choke-input filter. Plate voltage for modulators and final amplifier is taken from the output of the first filter stage. A bleeder is connected across the output of the second filter stage. Taps on the bleeder provide voltage for modulator screens, oscillator plate and screen, and microphone.

A 3-ampere fuse is connected in series with the primaries of the plate and filament transformers. This fuse is accessible from the panel. The ratings of the fuse has been chosen so that the fuse will blow when an abnormal load occurs on the plate supply, such as would be caused by a faulty component. Obviously a fuse of higher rating must not be used.

1.32 Receiver Power Supply

Voltage for filaments of tubes and pilot lamp is supplied from windings on receiver power transformer T-203. Plate Power is provided by a standard full-wave tube rectifier circuit, with a single-stage capacitor-input filter. R-206, in series with the negative terminal of the power supply, reduces plate voltage to the desired value.

1.4 Switching Circuits

Referring to Fig. 2.62, the Schematic Diagram, it is seen that "TRANS PWR" switch SW-201 interrupts primary voltage to the transmitter power supply. The primary of transmitter plate transformer T-202 is connected in series with contacts on send-receive relay (Relay-1).

"RECVR PWR" switch SW-202 interrupts primary voltage to the receiver power supply. The receiver "B.F.O." switch connects plate and screen voltage for b-f oscillator VT-106, and connects ground to the a-v-c bus, thereby deleting the a-v-c feature from the receiver during reception of c-w telegraph signals.

The coil of send-receive relay (Relay-1) is connected in series with the a-c filament voltage and the contacts of microphone switch SW-2. The contacts of "TRANS CW - RECV" switch SW-1 are connected in parallel with those of microphone switch SW-2, so that the send-receive relay (Relay-1) may be energized and released during c-w telegraph operation.

With send-receive relay (Relay-1) energized, the antenna is switched to the transmitter, primary voltage is applied to transmitter plate transformer T-202, and receiver plate voltage supply is opened. With Relay-1 released, the antenna is switched to the receiver, primary voltage to transmitter plate transformer T-202 is interrupted, and receiver plate supply circuit is completed.

The panel meter may be used to indicate either grid current or plate current in the final amplifier, the selection being made by means of a small toggle switch SW-301 mounted over modulation transformer T-2 inside the cabinet. Meter ranges are 0-15 ma for grid current, and 0-150 ma for plate current. After installation the switch is left so that the meter indicates plate current. R-301 is the 150-ma shunt for plate current. R-6 provides a return path for grid current when panel meter is switched to measure plate current, and has sufficiently high resistance to prevent objectionable shunting action on the meter.

1.5 Other Features

1.51 Antenna

The antenna is a half-wave off-center-fed doublet. For further information, see Sec. C9.101.

2.0 Adjustment and Repair, General

The following tools and equipment are needed for repair and adjustment of the Type M, Model D Radiophone:

(a) Usual complement of bench and hand tools.
(b) Tube checker.
(c) High-resistance d-c voltmeter, 1000 or more ohms per volt. A 20,000 ohms-per-volt instrument is to be preferred. Scales needed, 0-10, 0-250, 0-1000 volts.
(d) High resistance a-c voltmeter, copper-oxide-rectifier type, 1000 ohms per volt. Scales needed, 0-10, 0-50, 0-250, 0-1000 volts.
(e) Ohmmeter.

Note: Items (c), (d), and (e) may be obtained in a single combination instrument .

(f) Cathode-ray Oscilloscope.
(g) USFS Type A Test Set.
(h) Signal Generator, with range 2900 to 3500 kc, and also 465 kc.
(i) Audio power output meter. The 0-2.5 volt a-c range of item (d) may be used in place of item (i).

If the Radiophone fails to operate, the following procedure should be used to locate the trouble:

(1) Check to see if power has failed, or if a supply-circuit fuse has blown. If the receiver operates, but transmitter is dead, the transmitter fuse may have blown. Insert screwdriver in slot marked "FUSE" on panel, unscrew cover, and inspect fuse. If it has blown, replace with a new one. Use only a 3-ampere fuse.

(2) Examine antenna and lead-in wire. See that wires are in the clear, and make sure there are no broken connections.

2.1 Transmitter Data

If the transmitter fails to operate properly, make the tests outlined in "2.0 Adjustment and Repair, General". If this fails to clear the trouble, the next step is a series of tests which will indicate whether the trouble is in the power supply, r-f section, or modulator. Having thus localized the trouble, the search for faulty components may be concentrated within the section which is not performing properly.

2.11 Preliminary Tests to Localize Trouble

(1) Remove transmitter and receiver chassis from cabinet. After seeing that the power plug is withdrawn from its receptacle, remove the three screws from the rear of the cabinet which engage the transmitter chassis, then remove the eight screws which hold transmitter and receiver panels to the cabinet. Pull the receiver only part way out first, disconnecting the lead from the transmitter to the receiver antenna post. Pull the receiver out farther, and disconnect the transmitter-power-cable plug at the rear of the receiver chassis. The receiver may then be removed completely, withdrawing the radiophone power cord through the hole in the rear of the cabinet. Next the transmitter may be removed, withdrawing its power cable through the hole in the cabinet shelf.

(2) Inspect both chassis for apparent physical damage. Work the crystal and each tube in and out of its socket a few times to brighten the contacts. See that the crystal is inserted so that the "GRID" pin engages the ungrounded socket terminal.

(3) Insert transmitter-power-cable plug in receptacle on rear of receiver chassis. Connect dummy antenna load between "ANT" post and chassis. For information concerning suitable dummy antenna load, see Sec. C12.403, "Dummy Antennas for Adjusting Transmitters". In the absence of a dummy antenna, the regular antenna may be used, in which case the lead-in wire is connected to the "ANT" post, and no connection is made to the chassis. The dummy antenna is preferable, because its use eliminates radiation from the transmitter and possible interference during adjustment operations.

Turn "TRANS CW - RECV" switch to "RECV", and insert radiophone power plug in power receptacle. Turn "TRANS PWR" switch "ON". After allowing 30 seconds for filaments to heat, momentarily press microphone switch SW-2.

Note whether send-receive relay (Relay-1) operates. Failure of relay operation may be caused by mechanical faults on the relay, or by faults in the circuit associated with the relay coil. This circuit includes wiring and contacts in microphone switch SW-2. The relay should also operate when "TRANS CW - RECV" switch SW-1 is turned to "TRANS CW".

Note whether the power supply produces any unusual noise. Normally the hum is barely audible, and a louder sound indicates power supply overload. Do not permit sustained overload.

(4) Alternately press and release microphone switch SW-2 several times. Note whether action of relay is rapid and positive. See that contacts engage firmly, and that they are in good condition. If it is necessary to dress these contacts, this should be done with the utmost care to insure that they will contact over their full surfaces. A suitable method is to fold a piece of crocus cloth so that the abrasive surface of the cloth is on the outside. Insert the folded cloth between the contacts, press the contacts together, and pull the cloth out. Repeat several times, thereby brightening the contact surfaces. In cases of severe contact pitting it may be necessary to use folded <u>fine</u> emery cloth before securing the final surface with crocus cloth.

(5) If the relay is in good condition, and the power supply unit is relatively quiet, press microphone switch SW-2 and note reading on panel meter. When switched to measure plate current, meter range is 0-150 ma. Vary adjustment of "R" control, and note whether plate current dips as "R" is tuned through resonance, and note off-resonance plate current. Plate current at resonance should be about 75 ma, and off resonance about 85 ma. Failure of plate current to dip through resonance suggests that the oscillator is not operating. If plate current dips through resonance, yet off-resonance plate current is abnormally low, the oscillator may not be operating properly, a new final-amplifier tube (VT-2) may be needed, or plate voltage may be abnormally low due to a fault in the power supply. Leave "R" control adjusted for minimum plate current.

(6) Turn meter switch SW-301 to "GRID". When switched to measure grid current, meter range is 0-15 ma. Press microphone switch SW-2 and note meter reading. A normal reading of from 2 to 4 ma indicates that the oscillator is operating. Return meter switch SW-301 to "PLATE".

(7) Measure power-supply voltages. Measured voltages should be approximately as listed in Table 2.

Table 2
Power-Supply Voltages

Note: Voltages are measured to ground.

	d-c volts
Rectifier filament	445
Junction of L-201 and L-202 (Final Amplifier and Modulator Plates)	415
Junction of L-202 and R-201	400
Junction of R-201 and R-202 (Modulator Screens)	275
Junction of R-202 and R-203 (Oscillator Plate and Screen)	225
Junction of R-203 and R-204 (Microphone)	2 to 4
Total Current in High-Voltage Supply (Measured in secondary center tap)	215 to 230 ma (varies with modulation)

If measured voltages show a serious departure from tabulated values, see "2.3 Power Supply Data". When normal voltages have been restored the procedures of foregoing paragraphs (5) and (6) should be repeated.

(8) If preceding tests have indicated normal conditions, it may be assumed that a carrier is being produced, and the next step is a test for modulation. This may be done conveniently with a Type A Test Set. See Sec. C12.301, "Type A Test Set", Item 2.04. If no Type A Test Set is at hand, a radio receiver may be used. The receiver should be located far enough from the transmitter so that overloading in receiver circuits is avoided.

If the above test is not possible because of lack of equipment, modulator performance may be checked by measuring the a-f voltage induced in the secondary of the modulation transformer. Connect prods of a copper-oxide-rectifier a-c voltmeter across the secondary of modulation transformer T-2. A blocking capacitor may be inserted in series with the voltmeter to eliminate the slight deflection caused by d-c drop in the winding. Switch the voltmeter to the 1000-volt scale, press microphone switch SW-2, and whistle into the microphone. The actual deflection observed will depend upon final-amplifier loading and the intensity of the sound input to the microphone. A typical deflection will be about 450 volts.

(9) If all of the foregoing checks indicate normal conditions, it is probable that the transmitter is performing properly. If trouble

Press microphone switch SW-2, and slowly reduce the capacitance of C-4, watching both final amplifier grid current and oscillator plate current, as indicated by panel meter and external voltmeter, respectively. Oscillator plate current will dip sharply about the same time final-amplifier grid current starts. Continue to reduce the capacitance of C-4 until final-amplifier grid current is roughly maximum. Before completing the precise adjustment of the oscillator, the final amplifier should be resonated according to following paragraph (12). If there is a tendency toward unreliable starting, inspect crystal and crystal holder. Clean crystal, and see that holder does not bind edges of crystal.

(12) The next step is the adjustment of "R" and "L" controls for proper loading and for resonance in the final-amplifier plate circuit. To make this adjustment, see that meter switch SW-301 is turned to "PLATE", for which position meter will have a range of 0-150 ma. Press microphone switch SW-2, and tune "R" adjustment for minimum final-amplifier plate current, as indicated by panel meter. If this minimum current is less than 75 ma, turn "L" control so as to reduce capacitance of C-10, and again tune "R" for minimum panel-meter indication; if more than 75 ma, turn "L" control so as to increase C-10 capacitance, and repeat adjustment of "R" control for minimum panel-meter indication. This series of alternate adjustments of "L" and "R" controls is repeated until panel meter indicates 75 ma when "R" is tuned for minimum current. The adjustment of the "R" control is the last adjustment made.

(13) Return meter switch SW-301 to "GRID". With the 0-10 volt d-c meter connected across R-5, repeat the procedure of paragraph (11), adjusting oscillator tuning capacitor C-4 precisely for maximum final-amplifier grid current. If C-4 is turned past this point, it is not permissible to make a slight re-adjustment of C-4 in the reverse direction. C-4 should be returned to maximum capacitance, and the procedure repeated. After making this adjustment, alternately press and release the microphone switch several times to make sure the oscillator starts reliably. Return meter switch SW-301 to "PLATE".

(14) Detune only the "R" control, and observe maximum off-resonance plate current. If this current is less than about 85 ma, the need for a new final-amplifier tube is indicated. This of course presupposes that all previous checks on plate voltage and excitation have been made. Retune "R" control for minimum plate current.

(15) It may be observed that there is no setting of the "L" control which will result in an indication of 75 ma when the "R" control is adjusted for minimum plate current. This situation may be the result of a fault in the antenna or lead-in wire, or of an incorrect value of capacitance for loading capacitor padder C-16. If this difficulty is experienced, first inspect the antenna. If inspection shows the antenna to be in good shape, and in the clear, the capacitance of loading capacitor C-16 may need to be changed. If the minimum plate current loading obtainable by adjustment of "L" and "R" controls exceeds 75 ma,

capacitance of C-16 should be increased; if maximum loading is less than 75 ma, C-16 should be decreased. Although trial adjustments may be made with any good mica capacitors at hand, the capacitor finally installed should have a rating of 1000 working volts (2500 d-c volts test). A Cornell-Dubilier Type 4 or an Aerovox Type 1456 are satisfactory.

(16) Turn meter switch SW-301 to "GRID". Press microphone switch SW-2 and note final-amplifier grid current. This should be between 2 and 4 ma. Return meter switch to "PLATE".

(17) If the initial adjustment of the transmitter was poor, it will be well to re-check tube-element voltages with Table 3.

(18) Before replacing the transmitter in its cabinet, make sure meter switch SW-301 has been returned to "PLATE". The transmitter should be replaced first, taking care not to pinch the lead to the receiver antenna post under the transmitter chassis, In replacing the receiver, insert transmitter-power-cable plug and connect lead from transmitter to receiver antenna post. Finally, replace screws through rear of cabinet which engage the transmitter chassis, and replace panel screws.

(19) If a dummy antenna has been used during the foregoing adjustments, it will be necessary to re-resonate the final amplifier when the regular antenna is connected to the radiophone.

2.13 Modulator, Adjustment and Repair

(20) If the foregoing test of paragraph (8) indicates improper modulator performance, the first step is the checking of modulator tube voltages. See Table 3.

(21) Examine microphone and microphone cable for physical damage. Make continuity tests between pins on microphone plug P-1 to determine if wires are open. Flex the cable while making this test. Results of continuity tests should be as shown in Table 4.

Table 4

Normal Resistances between Pins on Microphone Plug

Continuity between Pins	Resistance, Micr. Button Released	Resistance, Micr. Button Pressed
#1 and #2	Open	1 Ohm
#3 and #4	50 to 200 ohms	50 to 200 Ohms
All Pins to Shell	Open	Open

(22) If the foregoing tests have not cleared the trouble, voltages across windings of microphone transformer T-1 and modulation transformer

T-2 should be measured with a copper-oxide-rectifier type a-c voltmeter, while whistling into the microphone. Observed voltage will depend somewhat on the intensity of the sound directed into the microphone and upon final-amplifier loading. Typical values are listed in Table 5.

Table 5

Typical A-F Voltages across Windings of Microphone and Modulation Transformers

T-1 Primary	0.25 Volt
T-1 Secondary	Meter barely deflects on 50-volt scale, due to meter loading on transformer.
T-2 Primary	650 Volts
T-2 Secondary	450 Volts

The presence or absence of normal voltages on the different windings will indicate the general location of the faulty component. Possible faults may include weak tubes, shorted or grounded transformer windings, and grounds or opens in the wiring. Transformer resistances may be compared with values given on Fig. 2.63, the Photodiagram.

(23) At the conclusion of repairs, the modulation should be checked, preferably with an oscilloscope. Using the directions of Sec. C12.402, "R-F Pick-up Device for Oscilloscope", adjust controls on oscilloscope for viewing modulated carrier in screen. Note whether modulation is complete for normal speech into the microphone, and whether there is evidence of over-modulation or serious distortion. If no oscilloscope is at hand, an audible check of the modulation may be made by use of the Type A Test Set. See Sec. C12.301, "Type A Test Set", Item 2.04.

(24) In replacing the radiophone in its cabinet, observe the directions of foregoing paragraph (18).

2.2 Receiver Data

If the receiver fails to operate, make the tests outlined under "2.0 Adjustment and Repair, General". If this fails to clear the trouble, use the following procedure to locate the fault.

(1) Remove the transmitter and receiver chassis from cabinet, using directions given in "2.1 Transmitter Data", paragraph (1). Work tubes in and out of their sockets a few times to brighten contacts. Plug transmitter-power-cable plug P-201 into receptacle on the rear of the receiver chassis, and plug radiophone power plug into power receptacle. Turn "TRANS CW - RECV" switch to "RECV", and turn "TRANS PWR" and "RECV PWR" switches "ON". Allow 30 seconds for filaments to heat.

(2) See that transmitter relay (Relay-1) operates properly, and that its contacts are making firm connections. When Relay-1 is released the antenna is switched to the receiver, and the receiver plate voltage supply circuit is completed. If contacts on the relay are pitted, see "2.1 Transmitter Data", paragraph (4). Turn "TRANS PWR" switch off.

(3) The power supply should produce a barely audible hum. An unusually loud noise from the power supply may indicate an overload. Do not permit sustained overload. Inspect each tube to see that it is lighted.

(4) Measure "B+" voltage at the output of the power supply filter. With normal line voltage this should be about 175 volts. If the voltage is substantially less than this amount, see "2.3 Power Supply Data".

(5) If power supply voltage is normal, check voltages on all tube elements. For tube-socket diagrams see Fig. 2.63, the Photodiagram. Normal heater voltage is 6.3 a-c volts. Voltages on other elements should be approximately as shown in Table 6, Measurements should be made with "R-F GAIN" knob turned all the way to the right.

<u>Table 6</u>

<u>Normal Receiver Tube-Element Voltages (Measured to Ground)</u>

(a) VT-101 R-F Amplifier	(Type 6K7)	
Plate Volts		170
Screen Volts		100
Cathode Bias		3
(b) VT-102 Converter	(Type 6A8)	
Plate Volts		170
Screen Volts		95
Anode-Grid Volts		105
Cathode Bias		3
(c) VT-103 I-F Amplifier	(Type 6K7)	
Plate Volts		170
Screen Volts		100
Cathode Bias		3
(d) VT-104 Detector and Audio	(Type 6Q7)	
Plate Volts		110°
Cathode Bias		1.7
(e) VT-105 Audio Putput	(Type 6K6G)	
Plate Volts		170
Screen Volts		175
Cathode Bias		16

(f) VT-106 B-F Oscillator (Type 6K7)

Plate Volts	31°
Screen Volts	12°

° A 1000-ohms-per-volt instrument will not indicate accurately for measurements marked "°". A 20,000-ohms-per-volt instrument should be used.

If there are serious departures from tabulated tube-element voltages, examine components associated with the tube-element in question. Search for shorted capacitors, and for resistors which show visible effects of over-heating.

(7) The receiver in the Type M Model D is identical electrically with that in the Type I Model D, except for power supply. The remainder of the instructions for adjustment and repair of the Type M Model D are covered in Sec. C13.8, "Type I Model D", from Item 2.2, "Receiver Data", paragraph (6), through Item 2.22, "Adjustment of B-F Oscillator".

2.3 Power Supply Data

The following instructions apply to repair of both transmitter and receiver power supplies, and should be followed if the tests outlined in "2.1 Transmitter Data", paragraph (7), or "2.2 Receiver Data", paragraph (4) show that either the transmitter or receiver power supply is defective.

Power supply failure may be caused by a ruptured filter or bypass capacitor, or by a shorted or weak rectifier tube. A breakdown of insulation may have occurred in a filter choke, the modulation transformer, rectifier-filament winding, receiver output transformer, or wiring. A ruptured capacitor or a breakdown of insulation can usually, although not always, be detected by resistance measurements. The following procedure should be used to locate the trouble.

(1) See that full line voltage is reaching primaries of power and filament transformers.

(2) Turn power switch off. Measure resistances to ground at rectifier filament, and at the junctions between filter chokes and between power-supply bleeder resistors. Normal values are listed in Table 7.

Table 7

Power Supply Circuit Resistances to Ground

(a) Transmitter Power Supply

Rectifier Filament	10,000 Ohms
Junction of L-201 and L-202	10,000 "
Junction of L-202 and R-201	10,000 "
Junction of R-201 and R-202	7,500 "
Junction of R-202 and R-203	6,500 "
Junction of R-203 and R-204	400 "

(b) Rectifier Power Supply

Rectifier Filament	32,000 ohms
Load Side of L-203	32,000 "
Junction of R-102 and R-103	24,500 "
Junction of R-101 and R-102	5,000 "

If measurements show abnormally high resistances, an open in the bleeder circuit is indicated. If abnormally low resistances are observed, a ground in the wiring or a breakdown of insulation in some component is indicated. The fault is usually closest in the circuit to the point at which the lowest resistance is observed. Individual components adjacent to the point showing the lowest resistance should be disconnected from the circuit and tested for shorts or grounds. However, there are some faults which will not respond to the low-voltage battery in the ohmmeter, and which become faults only upon application of high voltage. Such faults will not be detected by the above tests.

(3) Try a new rectifier tube, or one known to be in good order. If this substitution does not restore normal voltage after the tube has had time to warm up, turn the power off. The trouble may be a fault which appears only when high voltage is applied, and prolonged overload on the new tube should be avoided.

(4) Measure rectifier filament voltage. This measurement should show 5.0 a-c volts. In making this measurement avoid permitting one voltmeter prod to touch the chassis while the other touches a filament terminal. Such accidental contact may damage the meter. An abnormally low voltage may indicate shorted turns in the filament transformer, which condition should produce unusual heating in the transformer.

(5) Remove rectifier tube from its socket and measure a-c voltage from ground to each end of the plate-transformer secondary. Normally these measurements show about 575 a-c volts each on the transmitter, and about 265 a-c volts each on the receiver. Voltages on the two halves of a plate winding should not differ more than about 5 volts. An abnormally low voltage, or an abnormally large difference between voltages on the two halves of a plate winding suggests the presence of shorted turns in the transformer. Such shorted turns should produce unusual transformer heating. Compare resistances of transformer windings with normal values shown on Fig. 2.63, the Photodiagram.

Replace the rectifier tube.

(6) If the foregoing tests have not disclosed the trouble, a search should be made for faults which appear only upon the application of high voltage. One by one disconnect sections of the filter, bleeder, and load circuit from the power supply, measuring the voltage on the remainder of the power supply after each such isolation. Obviously the power must be

turned off while performing the disconnection, and must be turned on while making the voltage measurement. When the disconnection of a particular section restores normal or higher than normal voltage to the remainder of the supply, the fault may be assumed to be in the section just isolated. Portions of this section may then be re-connected to the supply, until the component is found whose inclusion results in loss of voltage. This component may be assumed to be faulty, and should be replaced.

In making these tests it will be convenient to refer to Fig. 2.62, the Schematic Diagram, and Fig. 2.63, the Photodiagram. It will be well to check filter choke resistances with normal values listed on the Photodiagram.

(7) At the conclusion of repairs the transmitter and receiver should be replaced in the cabinet according to the directions in "2.1 Transmitter Data", paragraph (18).

2.5 Parts List

2.51 Capacitors

Symbol	Component	Rating	Manufacturer	Type
C-1	Oscillator Cathode Bypass	.004 mfd.mica	Aerovox	1460
C-2	Oscillator Screen Bypass	.004 mfd.mica	Aerovox	1460
C-3	Oscillator Plate Return Bypass	.004 mfd.mica	Aerovox	1460
C-4	Oscillator Plate Tuning	50 mmf variable	Hammarlund	APC-50 Special Double-Spaced Cadmium-Plated
C-5	Final Amplifier Grid Return Bypass	.004 mfd.mica	(Aerovox (Solar	1467)* MW-1237)
C-6	Final Amplifier Cathode Bypass	.004 mfd.mica	(Aerovox (Solar	1467)* MW-1237)
C-7	Final Amplifier Screen Bypass	.002 mfd.mica 1250 WV	(Aerovox (Cornell- (Dubilier	1456)* 4-22020)
C-8	Final Amplifier Plate Blocking	.002 mfd.mica, 1250 WV	(Aerovox (Cornell- (Dubilier	1456)* 4-22020)
C-9	Final Amplifier Tuning	365 mmf variable	Cardwell	MR-365-BS
C-10	Final Amplifier Loading	365 mmf variable	Cardwell	MR-365-BS
C-11	Microphone Supply Bypass	20 mfd.150 volts Electrolytic	Mallory)	FPD-208
C-12	Modulator Cathode Bypass	20 mfd.150 volts Electrolytic	) Note: In some sets C-11 and C-12 each consisted of a Mallory Type BN-226 10-10 mfd. 75-V electrolytic, with dual sections connected in parallel. Type BN-226 is no longer available.	

*Or equivalent.

C-16	Additional Final Loading	.00025 mfd.mica 1250 WV	(Aerovox (Cornell- (Dubilier	1456) 4-23025)

Above value for C-16 is for matching Forest Service half-wave, single-wire-feed antenna. For matching 75-ohm line, use .002 mfd. 1250 WV mica capacitor (Identical with C-8).

Symbol	Component	Rating	Manufacturer	Type
C-101	Antenna Padder	50 mmf variable	Hammarlund	APC-50, Cadmium Plated
C-102	Antenna Tuning	25 mmf variable	Hammarlund	Note 1
C-103	R-F Amplifier Grid Return Bypass	.01 mfd. 600-V paper	Solar	S-0221
C-104	R-F Amplifier Cathode Bypass	.1 mfd. 400-V paper	Solar	S-0238
C-105	R-F Amplifier Screen Bypass	.02 mfd. 600-V paper	Solar	S-0224
C-106	R-F Amplifier Plate Return Bypass	.01 mfd. 600-V paper	Solar	S-0221
C-107	Converter Grid Padder	50 mmf variable	Hammarlund	APC-50, Cadmium Plated
C-108	Converter Grid Tuning	25 mmf variable	Hammarlund	Note 1
C-109	Converter Grid Return Bypass	.01 mfd. 600-V paper	Solar	S-0221
C-110	Converter Screen Bypass	.02 mfd. 600-V paper	Solar	S-0224
C-111	Converter Cathode Bypass	.1 mfd. 400-V paper	Solar	S-0238
C-112	H-F Oscillator Grid	.00005 mfd. mica	(Aerovox (Solar	1466*) MT-1310)

*Or equivalent.
Note 1: C-102, C-108, and C-115 on same shaft. Special Hammarlund 3-gang 25-50-25 mmf sections, HFD type construction.

Symbol	Component	Rating	Manufacturer	Type
C-113	H-F Oscillator Padder	.00004 mfd. mica	(Aerovox (Solar	1466)* MT-1308)
C-114	H-F Oscillator Padder	50 mmf. variable	Hammarlund	APC-50, Cadmium Plated

Symbol	Component	Rating	Manufacturer	Type
C-115	H-F Oscillator Tuning	50 mmf.variable	Hammarlund	Note 1
C-116	H-F Oscillator Anode Grid Blocking	.001 mfd.mica	(Aerovox (Solar	1466)* MT)
C-117	Converter Plate Return Bypass	.02 mfd.600-V paper	Solar	S-0224
C-118	I-F Amplifier Grid Return Bypass	.01 mfd.600-V paper	Solar	S-0221
C-119	I-F Amplifier Cathode Bypass	.1 mfd.400-V paper	Solar	S-0238
C-120	I-F Amplifier Screen Bypass	.02 mfd.600-V paper	Solar	S-0224
C-121	I-F Amplifier Plate Return Bypass	.02 mfd.600-V paper	Solar	S-0224
C-122	Diode Detector Load R-F Bypass	.00025 mfd.mica	(Aerovox (Solar	1466)* MT-1319)
C-123	A-V-C Diode Plate Coupling	.00025 mfd.mica	(Aerovox (Solar	1466)* MT-1319)
C-124	Volume Control Blocking	.01 mfd.600-V paper	Solar	S-0221
C-125	Detector Cathode Bypass	10 mfd.25 WV electrolytic	Mallory	BB-12
C-126	A-F Coupling	.1 mfd.400-V paper	Solar	S-0238

* Or equivalent
Note 1: See previous page.

Symbol	Component	Rating	Manufacturer	Type
C-127	Output Amplifier Cathode Bypass	10 mfd,25 WV electrolytic	Mallory	BB-12
C-128	A-F Coupling	.01 mfd.600-V paper	Solar	S-0221
C-129	B-F Oscillator Screen Bypass	.01 mfd.600-V paper	Solar	S-0221
C-130	B-F Oscillator Grid	.00025 mfd.mica (Note 2)	(Aerovox (Solar	1468)* MO-1419)
C-131	B-F Oscillator Tuning	Mica Compression Capacitor	Integral with L-107	

Symbol	Component	Rating	Manufacturer	Type
C-132	1st I-F Transformer Primary Tuning	Mica Compression Capacitor	Integral with T-101	
C-133	1st I-F Transformer Secondary Tuning	Mica Compression Capacitor	Integral with T-101	
C-134	2nd I-F Transformer Primary Tuning	Mica Compression Capacitor	Integral with T-102	
C-135	2nd I-F Transformer Secondary Tuning	Mica Compression Capacitor	Integral with T-102	
C-201	Transmitter Power Supply Filter	8 mfd.600-V Electrolytic	Mallory	HS-693
C-202	Transmitter Power Supply Filter	8 mfd.525-V Electrolytic	Solar	DM-508
C-203	Receiver Power Supply Filter	8-8 mfd.525-V Electrolytic	Solar	M-488
C-204	Receiver Power Supply Filter			

* Or Equivalent
Note 2: In same can with L-107.

2.52 Inductors

L-1	Oscillator Plate	45 turns #28 enameled wire close-wound on National Type XR-2 Form.		
L-2	Final Amplifier Grid	18 turns #32 enameled wire close-wound, fitted inside form for L-1.		
L-3	Final Amplifier Plate	36 turns #22 enameled wire wound on National Type XR-2 form, threaded 30 turns per inch.		
L-101) L-102)	Antenna Coil		Miller	Style 5853,Type 32-618

Symbol	Component	Rating	Manufacturer	Type
L-103) L-104)	Converter Coil		Miller	Style 5853, Type 32-620
L-105) L-106)	H-F Oscillator Coil		Miller	Style 5853, Type 32-619
L-107	B-F Oscillator Coil		Aladdin	C-350
L-201	Transmitter Power Supply Filter	13 Henries, 250 ma	Thordarson	T-75C51
L-202	Transmitter Power Supply Filter	15 Henries, 85 ma	Thordarson	T-16C07
L-203	Receiver Power Supply Filter	10 Henries, 40 ma	Thordarson	T-13C27
RFC-1	Final Plate Choke	2 mh, 125 ma	(Hammarlund (National (Coto	CH-X) R-100) CI-11)

2.53 Resistors

R-1	Oscillator Grid	50,000 Ohms, $\frac{1}{2}$ watt	IRC	BT-$\frac{1}{2}$
R-2	Oscillator Cathode	1,000 " 1 "	IRC	BT-1
R-3	Oscillator Screen Voltage Divider	25,000 " 1 "	IRC	BT-1
R-4	Oscillator Screen Voltage Divider	15,000 " 2 "	IRC	BT-2
R-5	Oscillator Plate Return Isolating	1,000 " 1 "	IRC	BT-1
R-6	Final Amplifier Grid Return	500 " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-7	Final Amplifier Grid Leak	15,000 " 1 "	IRC	BT-1
R-8	Final Amplifier Cathode	250 " 2 "	IRC	BT-2
R-9	Final Amplifier Parasitic Suppressor	50 " $\frac{1}{2}$ "	IRC	BW-$\frac{1}{2}$

Symbol	Component	Rating	Manufacturer	Rating
R-10	Final Amplifier Screen Isolating	20,000 Ohms, 2 Watt	IRC	BT-2
R-11	Modulator Cathodes	250 " 10 "	Ohmite	Brown Devil
R-101	Manual Gain Control Potentiometer	5,000 Ohms	Centralab	72-110
R-102	Voltage Divider	20,000 " 1 Watt	IRC	BT-1
R-103	Screen Voltage Dropping	7,500 " 2 "	IRC	BT-2
R-104	R-F Amplifier Grid Return Isolating	0.25 megohm ½ "	IRC	BT-½
R-105	R-F Amplifier Cathode	400 Ohms ½ Watt	IRC	BT-½
R-106	R-F Amplifier Screen Isolating	1,000 " ½ "	IRC	BT-½ Note 3
R-107	R-F Amplifier Plate Return Isolating	1,000 " ½ "	IRC	BT-½ Note 3
R-108	Converter Grid Return Isolating	0.25 Megohm ½ "	IRC	BT-½
R-109	Converter Screen Isolating	1,000 Ohms ½ "	IRC	BT-½ Note 4
R-110	Converter Cathode	300 " ½ "	IRC	BT-½
R-111	H-F Oscillator Grid Leak	50,000 " ½ "	IRC	BT-½
R-112	H-F Oscillator Anode Grid Dropping	25,000 " ½ "	IRC	BT-½
R-113	Converter Plate Return Isolating	1,000 " ½ "	IRC	BT-½ Note 4
R-114	I-F Amplifier Grid Return Isolating	0.25 Megohm ½ "	IRC	BT-½

Symbol	Component	Rating		Manufacturer	Type
R-115	I-F Amplifier Cathode	400 Ohms	½ Watt	IRC	BT-½
R-116	I-F Amplifier Screen Isolating	1,000 "	½ "	IRC	BT-½ Note 3
R-117	I-F Amplifier Plate Return Isolating	1,000 "	½ "	IRC	BT-½ Note 3
R-118	A-V-C Load	1 Megohm	½ "	IRC	BT-½
R-119	Diode Detector Load	0.5 "	½ "	IRC	BT-½
R-120	Detector Cathode	3,000 Ohms	½ "	IRC	BT-½
R-121	A-V-C Diode Plate Isolating	0.5 Megohm	½ "	IRC	BT-½
R-122	Volume Control Potentiometer	0.5 "	variable	Centralab	72-105
	Note 3, Note 4: See next page.				
R-123	Audio Amplifier Plate Load	0.1 Megohm	½ Watt	IRC	BT-½
R-124	Output Amplifier Cathode	1,500 Ohms	½ "	IRC	BT-½
R-125	Output Amplifier Grid Leak	0.5 Megohm	½ "	IRC	BT-½
R-126	Audio Amplifier Coupling	2 "	½ "	IRC	BT-½
R-127	B-F Oscillator Screen Voltage Divider	0.1 "	½ "	IRC	BT-½
R-128	B-F Oscillator Screen Voltage Divider	0.1 "	½ "	IRC	BT-½
R-129	B-F Oscillator Plate & Screen Dropping	0.25 "	½ "	IRC	BT-½
R-130	B-F Oscillator Grid Leak	0.1 "	½ "	IRC	BT-½ Note 2

Symbol	Component	Rating		Manufacturer	Type
	Note 2: In same can with L-107.				
	Note 3: In some receivers 1250 ohms has been used instead of 1000 ohms. Value is not critical.				
	Note 4: In some receivers 1500 ohms has been used instead of 1000 ohms. Value is not critical.				
R-201	Transmitter Power Supply Voltage Divider.	2500 Ohms	25 Watts	Ohmite	0208
R-202	Transmitter Power Supply Voltage Divider.	1000 "	10 "	Ohmite	Brown Devil
R-203	Transmitter Power Supply Voltage Divider	7500 "	25 "	Ohmite	0214
R-204	Transmitter Power Supply Voltage Divider	400 "	2 "	IRC	BT-2
R-205	Transmitter Filament Transformer Adjusting	50 "	adjustable 25 watts	IRC	DHA 50-ohms lug terminals
R-206	Receiver Power Supply Series Dropping	1000 "	10 "	Ohmite	Brown Devil

2.54 Tubes

Symbol	Component	Manufacturer	Type
VT-1	Oscillator	Sylvania or equivalent	6K6G
VT-2	Final Amplifier	RCA	807
VT-3	Modulator	Sylvania or equivalent	6L6G
VT-4	Modulator	" " "	6L6G
VT-101	R-F Amplifier	" " "	6K7
VT-102	Converter	" " "	6A8
VT-103	I-F Amplifier	" " "	6K7
VT-104	Detector	" " "	6Q7
VT-105	Output Amplifier	" " "	6K6G

Symbol	Component	Manufacturer	Type
VT-106	B-F Oscillator	Sylvania or equivalent	6K7
VT-201	Transmitter Rectifier	" " "	5Z3
VT-202	Receiver Rectifier	" " "	5W4

2.55 Transformers

T-1	Microphone	Phelps-Dodge	Inca 6985
T-2	Modulation	" "	Inca 7021
T-101	I-F Input	Aladdin	C-101M
T-102	I-F Output	"	C-200M
T-103	Audio Output	Jensen	Z-2370
T-201	Transmitter Filaments	Thordarson	T-79F84
T-202	Transmitter Plate	"	T-84P60
T-203	Receiver Power	"	T-13R19

2.56 Switches

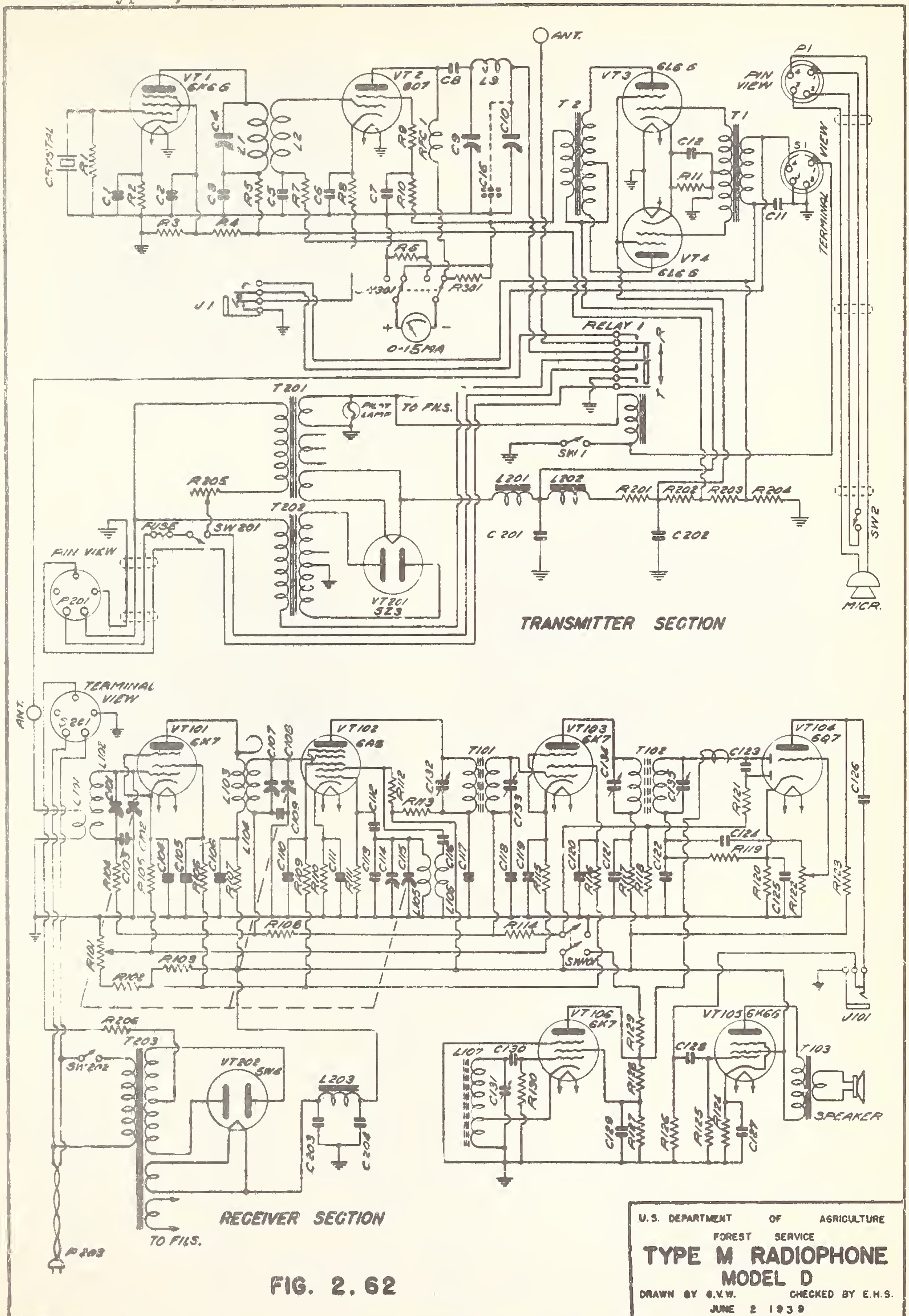
SW-1	Trans CW - Recv	H & H	SPST toggle, nickel plated with short shank.	
SW-2	Microphone "Push-to-Talk"	Built-in microphone.		
SW-101	B-F Oscillator On-Off	H & H	DPST toggle, nickel plated with short shank.	
SW-201	Transmitter On-Off	H & H	SPST toggle, nickel plated with short shank.	
SW-202	Receiver On-Off	H & H	SPST toggle, nickel plated with short shank.	
*SW-301	Transmitter Meter Switch	(H & H	DPDT toggle, nickel plated with short shank	Note 1
		(Mallory	S-3	Note 2

Note 1: In serial nos. M-195 and lower, except M-190. See Sec. C13.3, Item 2.71.
Note 2: In serial nos. M-196 and higher, and M-190.

2.59 Miscellaneous

Quantity	Symbol	Description	Manufacturer	Type
1	Micr	Microphone	Kellogg	FS-21C
1		Cord, Microphone	"	F-707
1	P-1	Plug, Microphone	Amphenol	MC4M
1	S-1	Socket, Microphone	"	PC4F
1		Cable, Transmitter Power, 2 feet flexible braid covered	Lenz	4-conductor battery cable per Lenz shop order 89272,mfd. for USDA,Forest Service.-
1	P-201	Plug, Transmitter Power Cable, 5-prong.	Amphenol	PM-5
1	S-201	Socket, Transmitter Power Cable	"	MIP-5
1		Cable, Radiophone Power, 10 feet flexible 2-conductor rubber covered,with male plug.	Belden	7902
1	J-1	Jack, Key cord	Mallory	704A
1	J-101	Jack, Headphones	Mallory	702
1	Crystal	Crystal, Low temperature Coefficient	Radio Specialty	A
1		Holder, crystal	Radio Specialty	A
1		Milliammeter,d.c. 0-15 ma with 0-150 scale	Triplett	Model 221
1	Relay-1	Relay, 6-v a-c winding	Leach	2123
1	Speaker	Speaker,5-inch permanent-magnet dynamic	Jensen	PM-5-DS
1		Key, Telegraph	Signal	112K
1		Cord, Key, 3 feet flexible 2-conductor rubber covered	Collyer	Ripcord

Quantity	Symbol	Description	Manufacturer	Type
1		Plug, Key Cord	Mallory	75
1		Headphones	Trimm	F-100
1		Plug, Headphones Cord	Mallory	75TC
1		Dial, Receiver Tuning	National	BM-2
2		Knobs, Receiver	Bud	750
1		Holder, Fuse	Littelfuse	1075
1	Fuse	Fuse,Size 3AG, 3 amperes	Buss	3AG
10		Sockets, Octal	Amphenol	MIP-8
1		Socket, 5-prong	"	RSS-5
1		Socket, 5-prong	Cinch	Y-16
1		Socket, 4-prong	Amphenol	MIP-4
2		Sockets, pilot lamp	ARHCo	1724
2		Lamps, pilot	General Electric Mazda	51
1		Lamp Cap,Transmitter Pilot Lamp.	Western "	4F
1		" " , Receiver Pilot Lamp.	" "	2L
2		Posts, Binding	X-L	"ANT" push post
2		Buttons,plug,for transmitter panel	Cinch	50628
2		Insulators, stand-off	Johnson	600
1		Tie Point, 1-terminal	Cinch	1516
2		Tie Points, 1-terminal	Cinch	1510
3		Tie Points, 2-terminal	Cinch	1520
4		Tie Points, 3-terminal	Cinch	1530
4		Tie Points, 4-terminal	Cinch	1540A
13		Grommets, rubber	ARHCo	1114
6		Grommets, rubber	ARHCo	1115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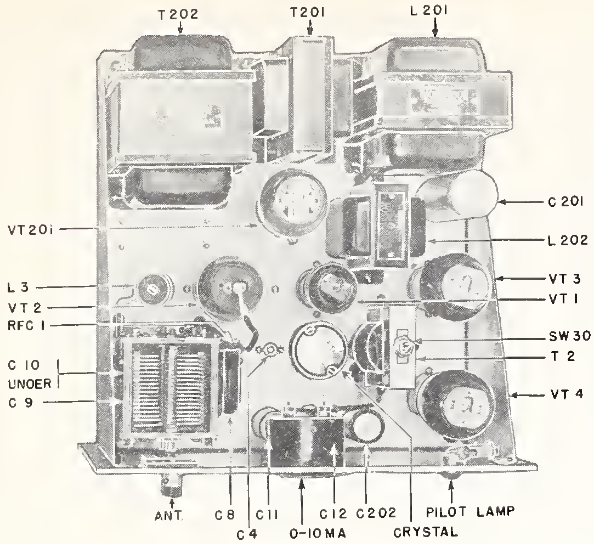
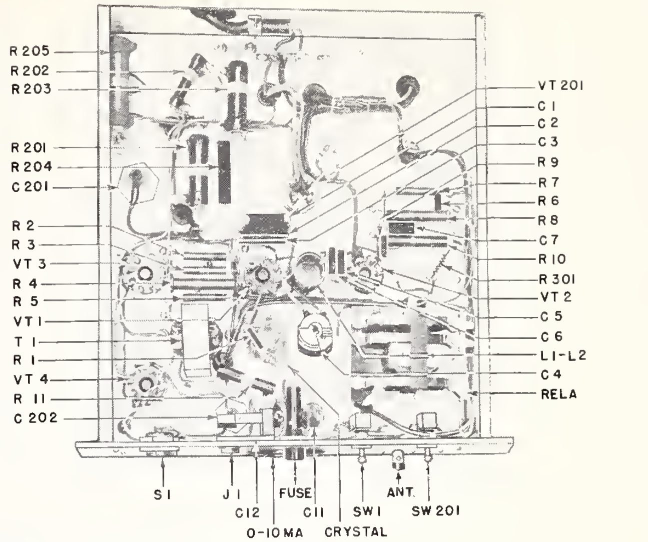
TRANSMITTER SECTION
RECEIVER SECTION
TO FILS.
TO FILS.
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE M RADIOPHONE
MODEL D
DRAWN BY G.V.W. CHECKED BY E.H.S.
JUNE 2 1939

FIG. 2.62

FIG. 2.63

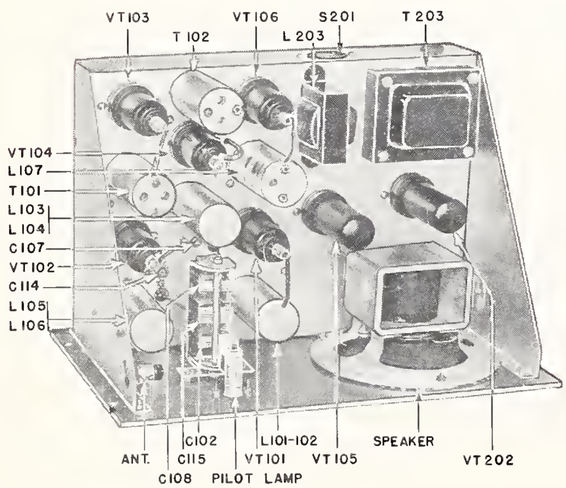


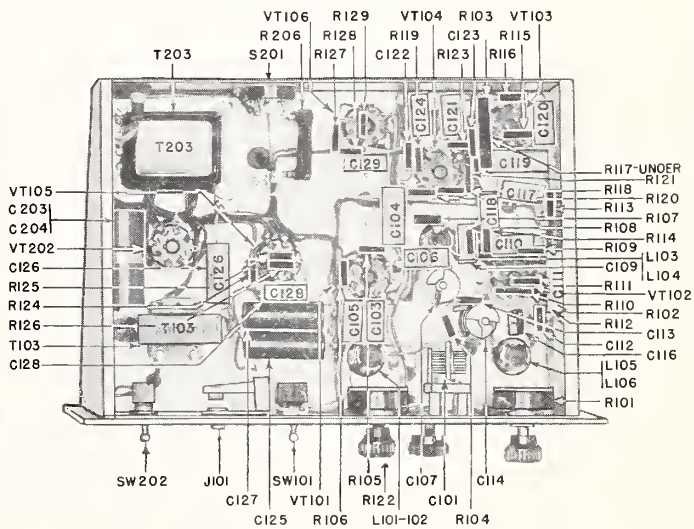


TOP

TRANSMITTER SECTION

BOTTOM

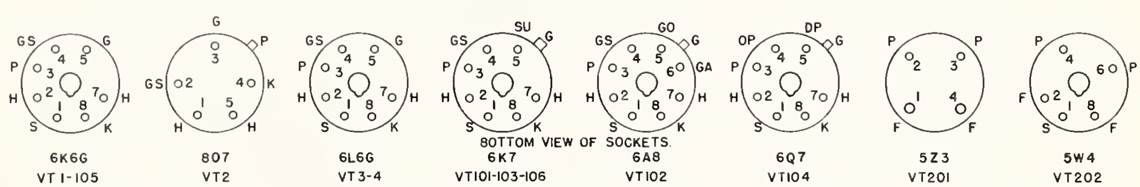


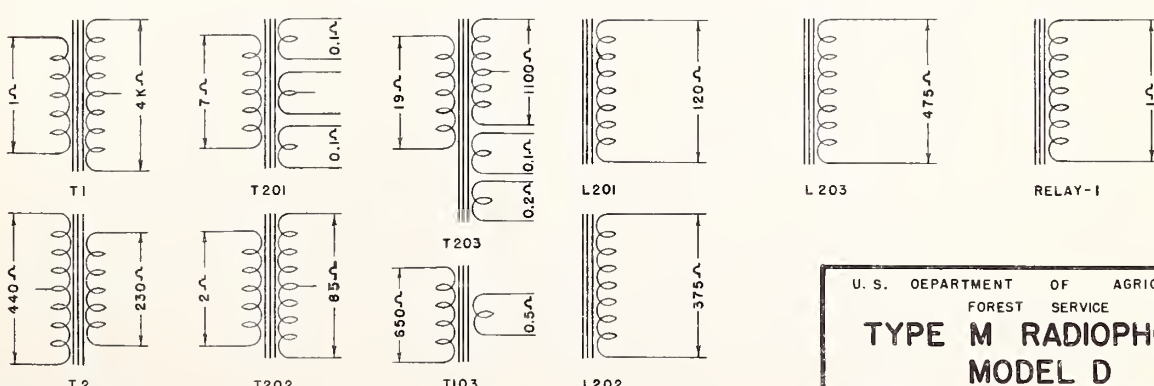


TOP

BOTTOM

RECEIVER SECTION





U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE M RADIOPHONE
MODEL D

PREPARED BY G.V.W. CHECKED BY E.H.S.
JULY 5 1939

2.7 Additional Data

2.71 Resistance in Meter Switches

A single milliammeter is used to indicate final-amplifier grid and plate currents. Meter switching has been provided by the small toggle switch SW-301 mounted over the modulation transformer.

These switches have shown a tendency to develop internal resistance, with the result that indicated plate current may be less than actual plate current. Sometimes the switch resistance is erratic, and the meter reading can be made to vary by manipulating the switch a few times. In other cases it is necessary to solder temporary jumpers around the switch contacts to detect the error. While such jumpers are in place, the switch should be left in the "PLATE" position, because throwing it to the "GRID" position will result in shorting of the plate supply.

Defective switches should be replaced. Where there are facilities for making slight mechanical changes in the mounting arrangement, a positive-indexing slide switch such as the Mallory S-3 is recommended for replacement. This type meter switch is supplied in serial numbers M-196 and higher, also M-190.

C13.4 Service Data Sheets

Type A

Model A Nos. 23 to 32 Inc.

Model ____ Nos. ____ to ____ Inc.

Model ____ Nos. ____ to ____ Inc.

Model ____ Nos. ____ to ____ Inc.

Model ____ Nos. ____ to ____ Inc.

Model ____ Nos. ____ to ____ Inc.

Model ____ Nos. ____ to ____ Inc.

Model ____ Nos. ____ to ____ Inc.

Note: For operating information see "Instructions for Operating," furnished with radio set.

C13.4 Type A, Model A.

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0.2 Physical Specifications

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2.2 Receiver Data

2.3 Power Supply Data

2.4 Switching Circuit Data

2.5 Parts List

2.6 Diagrams

0.0 General Description

The Type A Radiophone operates on voice only in the frequency range 32 to 39 megacycles. The range of transmission varies between 2 and 50 miles. In general, the ability to communicate between two points with Type A Radiophones depends upon the points being intervisible.

The frequency of the transmitter is maintained constant on one of the Forest Service assigned frequencies in the range 32 to 39 megacycles, by means of a crystal controlled oscillator. The receiver will receive voice signals on any frequency in the above range. The receiver is of the super-regenerative type, and may be used with either high or low impedance headphones.

The Type A Radiophone is intended primarily for temporary installation in aircraft and is designed for operation in an airplane without ignition shielding. Filament power is supplied directly from a 6-volt storage battery. Plate power comes from the same storage battery through a dynamotor. The antenna is about 13 feet in length, and is usually attached between the wing and tail of the plane by means of lines furnished. A single-button airplane type carbon microphone is used, and a push-button switch on the microphone actuates the relay which makes the necessary circuit changes from receive to transmit.

Both transmitter and receiver are housed in a metal case, with four unit sub-assemblies, which may be removed individually for adjustment or repair.

0.1 Electrical Specifications

Power Supply	6-volt Storage Battery
Frequency	32 to 39 Megacycles
Frequency Control	Crystal
Power Output	2.5 Watts
Working Range	Optical Path
Antenna	Half-Wave Doublet
Tubes, Transmitter	Type 89 Oscillator Type 89 Doubler Type 6A6 r-f Amplifier Type 41 Speech Amplifier Type 79 Modulator

Tubes, Receiver	Type 6K7 r-f Amplifiers (2) Type 6A6 Detector Type 6C5 First Audio Amplifier Type 6C5 Second Audio Amplifier
Output of Receiver	Headphones
Input to Transmitter	Hand Microphone
Type of Transmission	Voice Only

0.2 Physical Specifications

Approximate overall dimensions:

Height	18 inches
Width	13 "
Depth	$10\frac{1}{2}$ "
Weight, set only	25 pounds
Weight, complete, including dynamotor, headphones, microphone, connecting cable, but less storage battery	$40\frac{1}{2}$ "
Weight of 100 ampere-hour storage battery, approx.	40 "

PART 1

1.0 Detailed Description

The transmitter is located on the right-hand side of the front panel and the receiver on the left-hand side. All connections except the antenna are made with plug-in connectors polarized as necessary to prevent errors. Parts may be identified from the Parts List (2.5), the Schematic Diagram (2.62), and the Photodiagram (2.63).

1.1 Transmitter Circuit

The transmitter consists of an r-f section with crystal-controlled oscillator, double amplifier, and final amplifier; and an a-f section with speech amplifier and modulator stages.

The oscillator circuit is controlled by a quartz crystal ground to vibrate at a frequency one-eighth of that assigned to the transmitter. The voltage developed across this crystal is fed to the grid of the Type 89 oscillator tube, VT1, to which bias voltage is furnished by the flow of grid current through resistor R4. The r-f component of the grid current is prevented from following the same path by r-f choke RFC1. Coil L1 and capacitor C1 form the tune cathode circuit, operating near the crystal frequency. The plate circuit of VT1 is tuned by means of L2 and C2 to a frequency four times that of the crystal. Capacitor C9 serves as a bypass for the plate voltage. The grid of the Type 89 doubler amplifier tube, VT2, is excited through coupling capacitor C12 and furnished with bias voltage by grid current flowing through resistor R5 and RFC2, and by cathode current flowing through resistor R6. R6 is bypassed by capacitor C13. The plate circuit of tube VT2 is tuned to a frequency eight times that of the crystal by capacitor C3 and inductor L3, with capacitor C11 as a bypass for the plate current supply. The output of the doubler feeds into link circuit L4, whence it is conducted through banana plugs to the final r-f amplifier stage. Resistors R1, R2, and R3 form a voltage divider to furnish potential to the suppressors and screens of VT1 and VT2, that for the screens being taken off at the junction of R1 and R2 (bypassed by capacitor C10), and that for the suppressors being taken off at the junction of R2 and R3 (bypassed by C14). The heater current for these two tubes is brought in through two banana plugs, the negative A and negative B being common and positive B is brought in with a third plug.

The above components are located in the lower right-hand shielded compartment, behind the panel marked "T-2."

The grids of the Type 6A6 final amplifier tube VT3 are excited from the tuned circuit made up of L5 and C4, with grid bias furnished by the grid current drop through resistor R7 (bypassed by capacitor C8). This coil is connected to the previous doubler stage by banana plugs and the link circuit. The plates of VT3 feed into the tank circuit made up of split coil L6 and resonating capacitor C5, which is coupled to the antenna through coil L7. Neutralizing is effected by means of capacitors C6 and C7. Plate voltage is supplied through r-f choke RFC3 and the current is indicated by the meter in series with it. The heater current and positive B potential are brought in through banana plugs as in the previous stage.

Controls for capacitor C5 marked "RESONANCE" and for the coupling of coil L7 marked "LOADING" are brought out through the panel.

The above components are housed in the upper right-hand shielded compartment marked "T-1."

The variations of current appearing in the primary of the microphone transformer T1 induce voltage variations across gain control potentiometer R8, whence a portion of the voltage is applied to the grid of the Type 41 speech amplifier, VT4. This tube receives its bias from the cathode current drop in resistor R9 (bypassed by C15). The plate and screen are connected together to the primary of the driver transformer which is fed from the B positive supply, bypassed by C16.

The modulator stage VT5 is operated from the secondary of the driver transformer T2 as Class B with zero grid bias. The plates of this stage feed into the primary of the modulation transformer T3 whose secondary is connected in series with the plates of the final amplifier and thus effects modulation by the Heising system.

These a-f components are located on the bottom deck.

The microphone receives its voltage from the tap on resistor R10. This voltage is fed through jack J1, which also contains a contact to carry the return from switch SW3 in the microphone, which operates the relay.

1.2 Receiver Circuit

The receiver consists of a one-stage r-f amplifier, a superregenerative detector, and a two-stage a-f amplifier.

The antenna is connected through banana plugs to coil L101, which is inductively coupled to coil L102. The latter is tuned by capacitor C101, and the grids of the two Type 6K7 r-f tubes VT101 and VT102 are fed from its ends. The plates of these tubes work into the tuned circuit made up of C102 and L103. The output of this circuit feeds into the detector through a banana plug and receives its plate voltage through another, in series with choke RFC101. The screen voltage is lowered by resistor R102, bypassed by C104, and the control grid bias is developed by the cathode current flowing through resistor R101 (bypassed by C103).

Controls for capacitor C101 marked "R. F. INPUT" and for C102 marked "R. F. PLATE" are brought out through the front panel.

These components are housed in the upper left-hand shielded compartment, marked "R-1."

The Type 6A6 super-regenerative detector tube VT103 utilizes one set of triode elements as the detector proper and the other set as the quenching frequency oscillator. The output of the r-f stage is fed through coupling capacitor C105 into the tuned circuit L104 and C106. The detector grid is fed from one end of L104 (through capacitor C107) and the plate from the other end. Plate current is introduced into a tap on the coil through choke RFC102 (bypassed by capacitor C108). The oscillator plate is fed through one winding of oscillation transformer T101 which is tuned by capacitor C109 to some frequency above the audible range. Grid excitation for the oscillator is furnished by the other winding of T101 and grid bias by resistor R104, with grid capacitor C110. The detector plate current also traverses the primary of a-f transformer T102 (with capacitor C111 as r-f bypass) and induces an a-f voltage in its secondary which is applied to volume control resistor R105 (bypassed by C112).

These components are housed in the lower left-hand shielded compartment, with the volume control and the control for tuning capacitor C106 brought out through the front panel.

The a f output from the volume control is fed to the grid of the Type 6C5 first a-f tube VT105, whose plate circuit works into the primary of transformer T103. The secondary of transformer T103 feeds the grid of the Type 6C5 second a-f tube, VT104, whose plate works into the primary of the output transformer, T104. This transformer has a tapped secondary with one winding for high-impedance headphones and the other for low-impedance headphones. Each a-f stage derives its grid bias from cathode resistors, that for VT105 being R106 (bypassed by C114) and that for VT104 being R107 (bypassed by C113). Capacitor C115 is a bypass for the plate supply for the a-f stages.

The above components are located on the bottom deck, adjacent to the a-f components of the transmitter.

On some sets the plate voltage for the entire receiver is reduced below that applied to the transmitter by a resistor (R108) located between a contact on the relay and a tie point.

1.3 Power Supply Circuit

Power for the heaters is taken directly from the 6-volt storage battery and the high voltage is derived from the output of a dynamotor with appropriate filtering circuits.

When switch SW1 (marked "FIL.") is closed, voltage is applied to the heaters of the tubes through the filament filter choke L201, which is bypassed with capacitor C202. The yellow pilot light is also turned on.

The dynamotor will start when switch SW2 (Marked "GEN.") is closed, which also turns on the red pilot light. The high voltage output of the dynamotor is applied across capacitor C203 and thence is distributed to the various points where it is used in the equipment.

A cable with polarized plugs is used to connect the dynamotor and the set, and includes a pair of heavy duty clips for connection to the storage battery. The red clip, or the one stamped "+," must be attached to the positive terminal of the battery.

The base of the dynamotor contains two more filter circuits, with one made up of L202 and C204 on the low voltage side, and the other of L203 and C205, C206 and C207 on the high voltage side.

1.4 Switching Circuits

A relay, energized when the button on the microphone is pressed, is used to transfer positive B voltage and the antenna from receiver to transmitter. This relay is located immediately back of shielding compartment marked "R-1."

Jacks are provided on the front panel for the microphone, J1, and for high- and low-impedance headphones, J2 and J3. The polarized plug for the power also is fitted in the front panel.

PART 2

2.0 Adjustment and Repair, General

The following tools and equipment are needed for adjusting and aligning the Type A Radiophone:

(a) Usual complement of bench and hand tools for servicing.

(b) Tube checker.

(c) High resistance voltmeter -- 1000 ohms or more per volt. 0-10 volts and 0-500 volts, full scale.

(d) Cathode-ray oscilloscope.

(e) Coupling device for oscilloscope.

(f) Signal generator, 30 to 40 megacycles.

(g) Dummy load or 25-watt, 120-volt lamp.

General Procedure

(a) Check specific gravity of battery -- must be fully charged for testing. On a new battery, full charge is indicated by a specific gravity of 1.280.

(b) See that all battery and cable connections are clean and making good contact.

(c) Check tubes. Work tubes up and down in their sockets.

(d) See that banana plugs and jacks are clean and making good contact. (Units must be removed from set for this.)

(e) If set still fails to operate satisfactorily, make a detailed check of the circuit in accordance with the following data, the Schematic Diagram (2.62), the Photodiagram (2.63), and the Parts List (2.5).

2.1 Transmitter Data

1. Remove set from cabinet.

2. Open grid circuit of final amplifier and insert 0-10 milliammeter in series to indicate grid current. (See Note B, Fig. 2.63.)

3. Plug cables into set and dynamotor and connect to battery.

4. Place set in operation:

   (a) Throw SW1 (FIL.) on.

   (b) Wait 30 seconds for heaters of tubes to come to operating temperature.

   (c) Throw SW2 (GEN.) on.

   (d) Press button on microphone.

5. Place an r-f choke on negative prod of high resistance d-c voltmeter (high scale) and measure the voltage developed between the grid (cap) of VT1 (oscillator) and the frame of the set.

6. Adjust capacitor C1 (through side of shield compartment) until grid voltage is at maximum.

7. Transfer the r-f prod to the grid (cap) of VT2 (doubler) and adjust capacitor C2 (through side of shield compartment) until grid voltage is at maximum.

8. Connect dummy load in place of antenna (100 ohm 2-watt resistor).

9. Adjust capacitor C5 (resonance control on panel) for minimum plate current in the final amplifier as indicated by the panel meter.

10. Adjust link L7 (loading control on panel) until final plate current meter indicates about 20 milliamperes.

11. Adjust C3 and C4 to get maximum grid current in the final stage.

12. Readjust all capacitors except C5 to get maximum indication on the grid current meter. This is a more sensitive indicator than the voltmeter and a closer setting may be made this way.

13. The next step is the neutralization of the final stage. Disconnect plate voltage from VT3. Using the rectifier-wavemeter connection, resonate the USFS Type A Test Meter to transmitter frequency by coupling its coil to final grid coil L5, and adjusting dial for maximum Test Meter deflection. Coupling should not be closer than necessary to produce a meter indication.

With Test Meter tuning undisturbed, couple Test Meter coil to final tank coil, L6. Resonate final tank circuit by varying C5. Resonance will be indicated by maximum current in Type A Test Meter. Coupling between L6 and Test Meter coil should be adjusted so that this maximum current is somewhat above mid-scale.

Vary C6 and C7 for minimum or zero Test Meter current.

14. Neutralization may also be checked by again applying plate voltage and by seeing that maximum grid current occurs at the same setting of capacitor C5 as minimum plate current, or use the oscilloscope.

15. Throw all switches (Item 4) to an off position and disconnect final grid meter, replacing link across Fahnstock clips to close grid circuit.

16. Couple oscilloscope pick-up circuit to coil L6, adjusting the coupling to get a suitable pattern on the screen.

17. Check modulation by observing pattern on oscilloscope. Degree of modulation can be corrected by manipulation of R8.

18. Remove pick-up circuit.

19. Replace set in case.

2.2 Receiver Data

Owing to inherent properties of the circuit used in the Type A receiver, no alignment of circuits is required, and if the components are those specified in the parts list and diagrams and are in good order the receiver will operate properly. Servicing, therefore, is reduced to checking the tubes and the various other parts for departures from their correct values.

A super-regenerative receiver when operating properly gives a rushing sound in the headphones when a carrier is not tuned in. When carrier is picked up, this noise is greatly reduced, and with a strong signal will almost disappear. The noise, contrary to the conventional receiver, is a sign of correct operation rather than the contrary.

The USFS Type A Test Set, as a modulated oscillator, may be used to check the super-regenerative action over the entire 30-40 megacycle band. Failure of receiver to super-regenerate smoothly over the entire range can often be corrected by replacing VT-103.

The detector tuning dial will ordinarily track rather closely with the "R. F. INPUT" and the "R. F. PLATE," although exact correspondence should not be expected. In searching for a signal the three controls should be operated together as nearly as possible, and when the station sought is found, the three controls should be individually adjusted to bring it to a maximum.

2.3 Power Supply Data

The dynamotor supplied with this unit is lifetime lubricated and should not require attention other than an occasional inspection to determine the condition of the carbon commutator brushes.

The filter system contained in the base of the dynamotor is composed of r-f and audio filter sections interwired so that they do not appear as separate circuits. Any failure in this part of the equipment can usually be traced to a defective filter condenser, either the mica r-f filter or the electrolytic commutator filter condensers.

2.4 Switching Circuit Data

Usually no trouble will be experienced with the relay, but where used in dusty or corrosive atmosphere it may be necessary to clean and smooth up the contacts. Very fine (00 grade) sandpaper may be used for this and the contacts may be lightly pressed together against the abrasive surface of a folded piece as it is moved between the contacts.

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2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
C1	Oscillator cathode tuning	100 mmf	Hammarlund	APC-100	
C2	Oscillator plate tuning	50 mmf	"	APC-50	
C3	Quadrupler plate tuning	25 mmf	"	APC-25	
C4	Final grid tuning	25 mmf	"	APC-25	
C5	Final plate tuning	35 mmf	"	MCD-35-SX	
C6	Final neutralizing	(special, reduced to 4 plates)	"	APC-25	
C7	Final neutralizing	(special, reduced to 4 plates)	"	APC-25	
C8	Final grid bypass	.0005 mf mica	(Solar (Aerovox	MT) 1465)	or equivalent
C9	Oscillator plate bypass	.001 mf mica	(Solar (Aerovox	MW) 1465)	"
C10	Screen bypass	.005 mf mica	(Solar (Aerovox	MW) 1467)	"
C11	Quadrupler plate bypass	.002 mf mica	(Solar (Aerovox	MW) 1467)	"
C12	Quadrupler grid coupling	.00007 mf mica	(Solar (Aerovox	MO) 1468)	"

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SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
C13	Quadrupler cathode bypass	.0001 mf mica	(Solar (Aerovox	MO) 1468)	or equivalent
C14	Suppressor bypass	.005 mf mica	(Solar (Aerovox	MO) 1467)	"
C15	A-f driver cathode bypass	25 mf 25 volts	Solar	DDB-669	
C16	A-f driver plate bypass	1 mf 400 "	(Aerovox (Solar	461) P-1921)	"
C101	R-f grid tuning	25 mmf (special, with $1\frac{1}{2}$" fibre shaft)	Hammarlund	APC-25	
C102	R-f plate tuning	25 mmf (special, with $1\frac{1}{2}$" fibre shaft)	Hammarlund	APC-25	
C103	R-f cathode bypass	.005 mf mica	(Solar (Aerovox	MH) 1461)	"
C104	R-f screen bypass	.005 mf mica	(Solar (Aerovox	MH) 1461)	"
C105	Detector grid coupling	30 mmf	Hammarlund	MEX-30	
C106	Detector grid tuning	25 mmf (special, with $1\frac{1}{2}$" fibre shaft)	Hammarlund	APC-25	
C107	Detector grid blocking	.00005 mf mica	(Solar (Aerovox	MT) 1465)	"
C108	Detector plate bypass	.00001 mf mica	(Solar (Aerovox	MO) 1468)	"

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SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
C109	Oscillator plate tuning	.002 mf mica	(Solar (Aerovox	MW) 1467)	or equivalent
C110	Oscillator grid blocking	.0015 mf mica	(Solar (Aerovox	MW) 1467)	"
C111	A-f trans. primary bypass	.006 mf	(Solar (Aerovox	MH) 1460)	"
C112	A-f trans. secondary bypass	.0005 mf	(Solar (Aerovox	MT) 1465)	"
C113	First a-f cathode bypass	25 mf 25 volts	Solar	DDB-669	
C114	Second a-f cathode bypass	25 mf 25 "	Solar	DDB-669	
C115	A-f plate bypass (in some sets only)	12 mf 450 "	Mallory	CS-135	
C116	R-f filter (in some sets only)	.00007 mf mica	(Solar (Aerovox	MT) 1465)	"
C201	Filament r-f bypass	.0005 mf mica	(Solar (Aerovox	MT) 1465)	"
C202	Filament a-f bypass	.5 mf paper	(Solar (Aerovox	P-1503) 260)	"
C203	Plate r-f bypass	.0005 mf mica	(Solar (Aerovox	MT) 1465)	"
C204	Dynamotor filter	.25 mf 25 volts	(Fast, John E (Solar (Aerovox	---) P1502) 260)	"

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SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE	
C205	Dynamotor filter	.005 mf mica	(Solar (Aerovox	MW) 1467)	or equivalent
(C206) (C207)	Dynamotor filter	4-8 mf	(Fast, John E (Solar (Aerovox	---) P1502) 260)	"
C208	Dynamotor filter	.005 mf mica	(Solar (Aerovox	LG5-48) PBS-450)	"

2.52 Inductors

SYMBOL	COMPONENT	NUMBER OF TURNS	WIRE	FORM DIAMETER	LENGTH OF WINDING
L1	Oscillator cathode	25	#22 AWG enamel	1 inch	1-1/16 inch
L2	Oscillator plate	10	#22 " "	1 "	9/16 "
L3	Quadrupler plate	5	#18 " "	1 "	1/4 "
L4	Link Circuit	2	#18 " "	1 "	1/8 "
L5	Final grid	8	#18 " "	1 "	1 "
L6	Final plate	4 & 4	1/8" tubing	1 "	3/4" ea. half
L7	Antenna coupling transmitter	2	#14 AWG enamel	1 "	1/8 inch
L101	Antenna coupling receiver	2	#22 " "	spaced over L102	1/8" away
L102	R-f grid	6	#22 " "	1 inch	5/8 inch
L103	R-f plate	5	#22 " "	1 "	1/2 "
L104	Detector grid	6	#20 " "	1 "	5/8 "
L201	Filament choke	8	#14 " "	3/4 inch	9/16 "

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SYMBOL	COMPONENT	MANUFACTURER	TYPE	
L202	Dynamotor "A" choke	Pioneer	——	
L203	Dynamotor "B" choke	Pioneer	T-7471	
RFC1	Oscillator grid choke	(Hammarlund (Miller	CH-X) 4538)	or equivalent
RFC2	Quadrupler grid choke	(Hammarlund (Miller	CH-X) 4538)	"
RFC3	Final plate choke	(Hammarlund (Miller	CH-X) 4538)	"
RFC101	R-f plate choke	(Hammarlund (Miller	CH-X) 4538)	"
RFC102	Detector plate choke	Ohmite	Z-1	
RFC201	Dynamotor r-f filter	(Miller (Meissner	650) 4551)	"
RFC202	Dynamotor r-f filter	(Miller (Meissner	650) 4551)	"

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R1	Voltage divider	10,000 ohms 2 watt	IRC	BT2
R2	Voltage divider	12,000 " 2 "	IRC	BT2
R3	Voltage divider	5,000 " 2 "	IRC	BT2
R4	Oscillator grid bias	50,000 " 1 "	IRC	BT1

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SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R5	Quadrupler grid bias	40,000 ohms 1 watt	IRC	BT1
R6	Quadrupler cathode	1,000 " 1 "	IRC	BT1
R7	Final grid bias	1,000 " 1 "	IRC	BT1
R8	A-f gain setting	.25 megohm	(Centralab) (Mallory)	(72-121) or (Y-250 MP) equiv.
R9	Driver cathode	500 ohms 1 watt	IRC	BT1
R10	Microphone voltage dropping	50 "	(Mallory) (Bud)	(850C) " (851)
R101	R-f cathode	150 " 1 watt	IRC	BT1
R102	R-f screen	40,000 " 1 "	IRC	BT1
R103	Detector grid	1 megohm ½ "	IRC	BT½
R104	Oscillator grid	10,000 ohms ½ "	IRC	BT½
R105	Volume control	.25 megohm	Centralab	72-121
R106	First a-f cathode	1,000 ohms 1 "	IRC	BT1
R107	Second a-f cathode	1,000 " 1 "	IRC	BT1
R108	Receiver voltage dropping	4,000 " 10 "	Ohmite	Br. Devil

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2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT1	Crystal oscillator	RCA, Sylvania, or equivalent	89
VT2	Frequency multiplier	" " " "	89
VT3	Final amplifier	" " " "	6A6
VT4	Speech amplifier	" " " "	41
VT5	Modulator	" " " "	79
VT101	R-f amplifier	" " " "	6K7
VT102	" "	" " " "	6K7
VT103	Detector - Oscillator	" " " "	6A6
VT104	Second audio amp.	" " " "	6C5
VT105	First " "	" " " "	6C5

2.55 Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T1	Microphone	Phelps-Dodge	02678
T2	Driver	" "	02427
T3	Modulation	" "	02927
T101	Oscillation	National	OSR
T102	First a-f	Phelps-Dodge	04345
T103	Second a-f	" "	04753
T104	Output a-f	" "	04340

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2.56 Switches

SYMBOL	COMPONENT	MANUFACTURER	TYPE
SW1	Filament ("FIL.")	(Bryant) (Hubble)	(IL-1312) (" ")
SW2	Dynamotor ("GEN.")	(Bryant) (Hubble)	(IL-1312) (" ")
SW3	Microphone	Built in microphone	

2.59 Miscellaneous

QUANTITY	COMPONENT	MANUFACTURER	TYPE
1	Relay-special coil; 6 volt, 12 ohms	Leach	2056
1	Meter, 0-100 ma. d-c	Weston	Model 506, type F02
1	Detector tuning dial	National	BM1
3	Dials	Crowe	262
3	Knobs	Bud	805
1	Microphone, airplane	Kellogg	T17
1	Headphones, metal band, 2000 ohms	Trimm	USFS, type F-100
2	Sockets, octal wafer	Cinch	015
2	Sockets, octal 6-prong	Cinch	Z18
2	Sockets, ceramic 6-prong	Hammarlund	S-6
2	Sockets, ceramic 7-prong	Hammarlund	S-7-B
2	Sockets, ceramic octal	National	
1	Shaft coupling	National	TX10

QUANTITY	COMPONENT	MANUFACTURER	TYPE
16	Butt-in	Communication Products	CP
1	Bar knob	(Bud (Crowe	579) 286)
2	Pilot lamps, 6.3 v., 1 red, 1 yellow	National Carbon	Bulb T-$3\frac{1}{4}$ Base Min.
1	Battery cable plug-in	Jones	S-4-AB 1/16
2	Battery cable plug-in	Jones	P 4RST
1	Dynamotor, with special filter	Pioneer	E2
2	Battery clips, 1 marked "+"	Mueller	21A
1	J1 Microphone jack	Mallory	702-B
1	J2 High impedance output	Mallory	A-1
1	J3 Low impedance output	Mallory	A-1
2	Pilot lamp socket	Mallory	304-CH
26	Jacks	Johnson	74
26	Plugs	Johnson	75
2	Antenna posts	X-L Radio Laboratories	X-L Pushpost "ANT"
1	Low capacity cable for receiver stage coupling	(fabricated by set manufacturer)	
5	Feet cable, containing: 3 - #8 flexible BRC conductors 2 - #14 " " " with outer braid covering, Lenz, special		
4	Feet #12 flexible BRC wire, Packard, low tension, automotive		
1	Crystal, A-cut	Radio Specialty Mfg. Co.	A
1	Holder, crystal	Radio Specialty Mfg. Co.	A

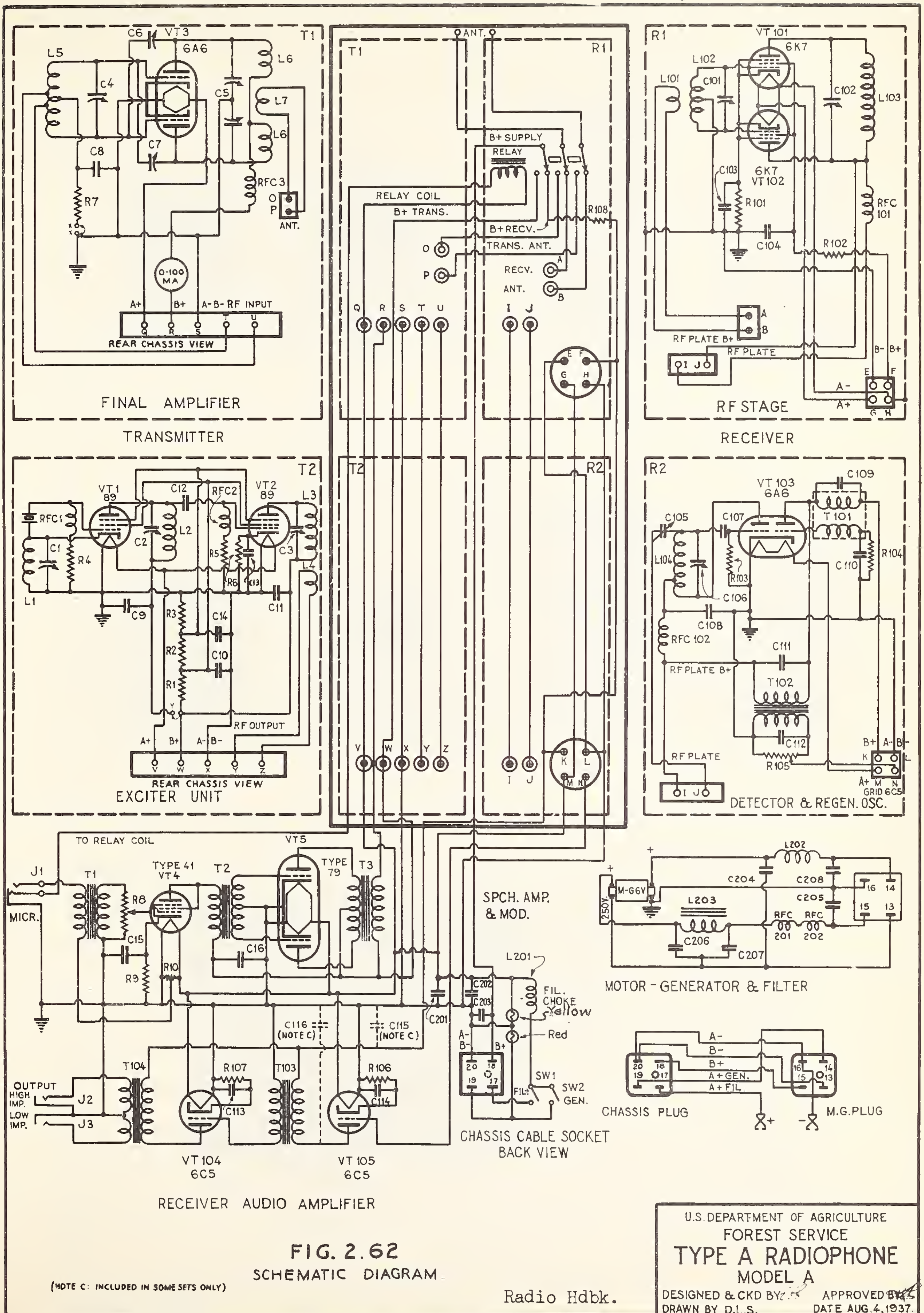

FIG. 2.62
SCHEMATIC DIAGRAM

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE A RADIOPHONE
MODEL A
DESIGNED & CKD BY
APPROVED BY
DRAWN BY D.L.S.
DATE AUG. 4, 1937.

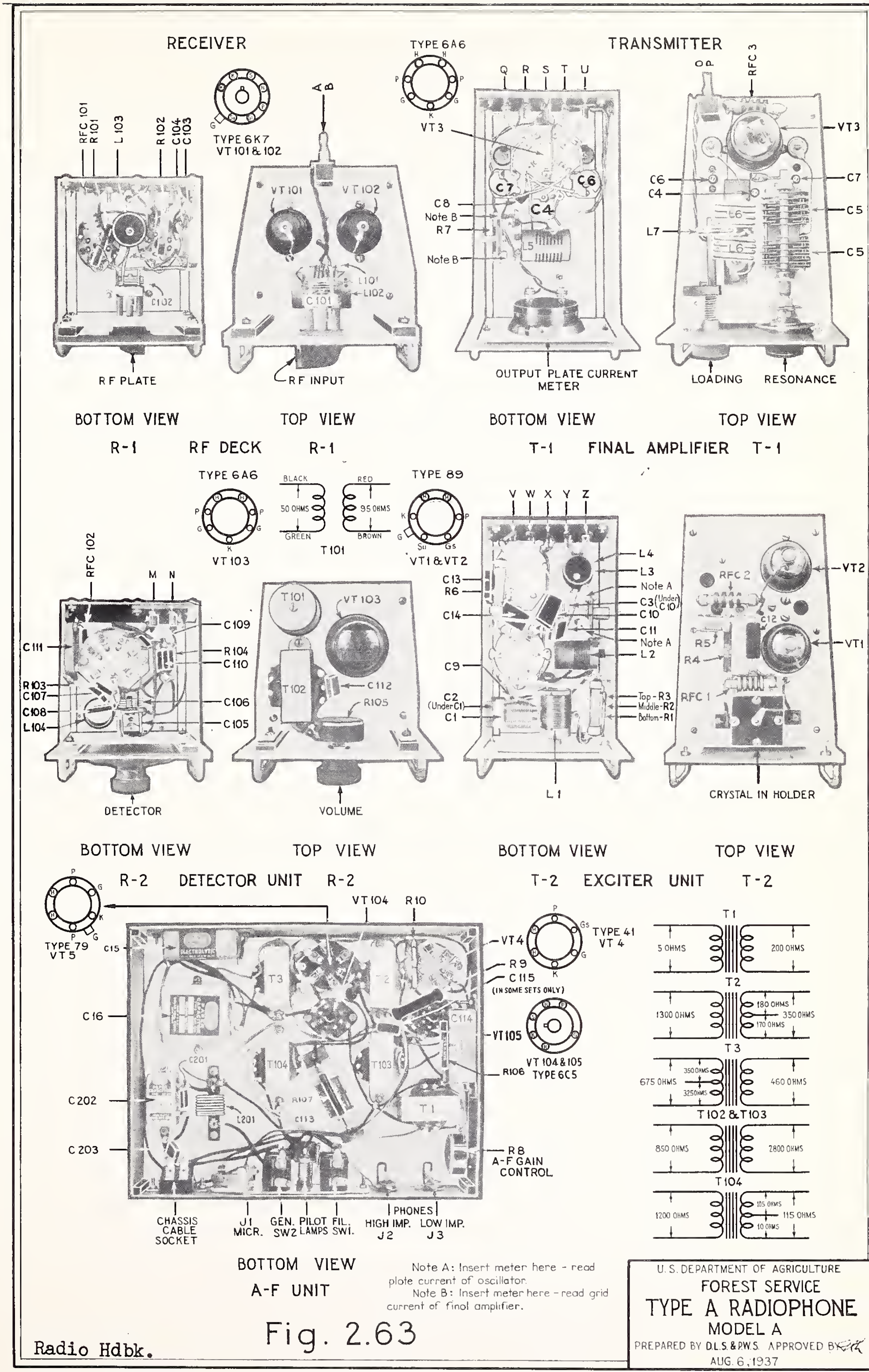
RECEIVER
TRANSMITTER
TYPE 6K7
VT 101 & 102
TYPE 6A6
VT 3
A
B
RFC 101
R 101
L 103
R 102
C 104
C 103
C 102
VT 101
VT 102
L 101
L 102
C 101
R F PLATE
R F INPUT
Q R S T U
RFC 3
O.P.
VT 3
C 8
Note B
R 7
C 7
C 6
C 4
L 5
C 6
C 4
C 7
C 5
L 7
L 6
OUTPUT PLATE CURRENT METER
LOADING
RESONANCE
BOTTOM VIEW
TOP VIEW
R-1 RF DECK R-1
T-1 FINAL AMPLIFIER T-1
TYPE 6A6
VT 103
BLACK
RED
50 OHMS
95 OHMS
GREEN
BROWN
T 101
TYPE 89
VT 1 & VT 2
RFC 102
M N
C 111
R 103
C 107
C 108
L 104
C 109
R 104
C 110
C 106
C 105
T 101
VT 103
T 102
C 112
R 105
DETECTOR
VOLUME
V W X Y Z
C 13
R 6
C 14
C 9
C 2 (Under C1)
C 1
L 4
L 3
Note A
C 3 (Under C 10)
C 10
C 11
Note A
L 2
Top - R 3
Middle - R 2
Bottom - R 1
L 1
RFC 2
VT 2
C 12
R 5
R 4
VT 1
RFC 1
CRYSTAL IN HOLDER
BOTTOM VIEW
TOP VIEW
R-2 DETECTOR UNIT R-2
T-2 EXCITER UNIT T-2
TYPE 79
VT 5
C 15
VT 104
R 10
VT 4
TYPE 41
VT 4
R 9
C 115
(IN SOME SETS ONLY)
VT 105
VT 104 & 105
TYPE 6C5
R 106
C 16
C 202
C 203
R 8
A-F GAIN CONTROL
T 3
T 2
C 114
C 201
T 104
T 103
R 107
L 201
C 113
T 1
CHASSIS CABLE SOCKET
J 1 MICR.
GEN. SW 2
PILOT LAMPS
FIL. SW 1.
PHONES
HIGH IMP. J 2
LOW IMP. J 3
T 1
5 OHMS
200 OHMS
T 2
1300 OHMS
180 OHMS
350 OHMS
170 OHMS
T 3
675 OHMS
350 OHMS
3250 OHMS
460 OHMS
T 102 & T 103
850 OHMS
2800 OHMS
T 104
1200 OHMS
105 OHMS
115 OHMS
10 OHMS
BOTTOM VIEW
A-F UNIT
Note A: Insert meter here - read plate current of oscillator.
Note B: Insert meter here - read grid current of final amplifier.
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE A RADIOPHONE
MODEL A
PREPARED BY D.L.S. & P.W.S. APPROVED BY
AUG. 6, 1937

Fig. 2.63

C13.5 Service Data Sheets

Type S

Model A Nos. 344 to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Note: For operating information see "Instructions for Operating," furnished with radio set.

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0.0 General Description

The Type S Radiophone operates in the frequency range 32 to 39 megacycles. Voice only is transmitted, and a maximum range of 50 miles by optical paths is provided. The working range with the antenna close to the ground and over level terrain may be reduced to less than 2 miles.

Since the same tubes are used in both the transmitting and receiving circuits, this set cannot be used to work duplex, but must alternately transmit and receive.

In the Type S, which has a single r-f oscillator circuit and tube for both transmitter and receiver, transmitter operation takes place on a slightly different frequency from receiver operation for a given dial setting. This has resulted in the necessity to re-tune at the start of each reception, at both stations which are in communication. The two stations, in thus following each other's frequency changes, will drift across a substantial portion of the frequency band during a contact.

The advantages of the Type S Radiophone are its extreme portability, the ease and speed with which it may be placed in operation, and the fact that it may be used to transmit and receive while on moving vehicles.

The entire Radiophone is contained in a small wooden case, and weighs about 9 pounds complete with batteries.

0.1 Electrical Specifications

Power Supply	Dry Batteries
Frequency Range	32 to 39 Megacycles
Frequency Control	Self-Excited Oscillator
Power Output	One-Tenth Watt
Working Range	Optical Path--About 50 Miles Maximum
Antenna	Half-Wave Type, End Fed
Tubes	1 Type 30 Detector-Oscillator 1 Type 49 Amplifier-Modulator
Output	Light-Weight Headphones
Input	Hand Microphone
Type of Transmission	Voice Only

0.2 Physical Specifications

Approximate overall dimensions of unit:

Height	7 inches
Width	6 inches
Length	11 inches
Weight, complete with batteries	9 pounds

PART 1

1.0 Detailed Description

The entire set is mounted on a single panel and sub-panel, which holds all of the parts except the A and B batteries. The change from Transmit to Receive is effected by means of an anti-capacity switch, which, in the mid position, shuts off the entire set. Parts may be identified from the Parts List (2.5), the Schematic Diagram (2.62), and the Photodiagram (2.63). A given component part is designated by the same symbol on the Parts List, the Schematic Diagram, and the Photodiagram.

1.1 Transmitter Circuit

With the switch in the "TRANS" position, the circuit arrangement is as shown in Fig. 1.1 (Section 2.62), and functions in the following manner.

When sound waves strike the diaphragm of the microphone, variation in the resistance between the carbon granules takes place, and the current through the primary of Transformer T1 is varied in a corresponding manner. This impresses an alternating voltage upon the grid of the modulator, VT2, which, in turn, changes its plate current. Since the oscillator, VT1, receives plate current through the secondary of transformer T2, its plate voltage will be varied with the changes in plate current of VT2. Modulation takes place according to the Heising system. The oscillator circuit is made up of the coils L1 and L2, the blocking capacitor C2, tuning capacitor C1, and the inter-electrode capacitances. These inter-electrode capacitances establish the ground point on the tuned circuit. Grid bias is supplied by resistor R1. The antenna is coupled to L1 through capacitor C3. C4 and C5 are bypass capacitors in the plate return and filament circuits, respectively. The filament voltage is reduced to the proper value by resistor R3, and bias is furnished to the modulator by the 7½-volt battery.

1.2 Receiver Circuit

With the switch in the "RECV" position the circuit arrangement is as shown in the Fig. 1.2 (Section 2.62), and functions in the following manner:

When an incoming signal strikes the antenna ("ANT"), it is fed through capacitor C3 to coil L1. Coil L1 is inductively coupled to coil L2, which excites the grid of VT1. This tube functions as a self-quenching super-regenerative detector, and its a-f output is fed through the r-f choke RFC, by-passed by capacitor C4, to a third winding on transformer T1. Resistor R2 furnishes the grid bias, and capacitor C1 tunes the detector circuit. The output of transformer T1 is applied to the grid of tube VT2, whose variable plate current transfers a voltage to the headphones through its secondary, and capacitor C6. The filament circuit and by-pass capacitors are the same as in the transmitting position. The circuit change from Fig. 1.1 to Fig. 1.2 is effected by the anti-capacity switch, as may be seen in the Schematic Diagram, Fig. 2.62.

1.3 Power Supply Circuit

The Type S Radiophone requires a 3-volt A battery and a 90-volt B battery. Current drains are approximately as follows:

	"TRANS" Position	"RECV" Position
A Battery	250 ma	180 ma
B Battery	21 ma	11 ma

Three combinations of battery types may be used, as shown on Fig. 2.62.

(*) 1.5 Antenna

The antenna is a half-wave end-fed wire. See Parts List for dimensions and components.

2.0 Adjustment and Repair, General

Tools and Equipment Required

The following tools and equipment are needed for adjusting the Type S Radiophones:

(a) Usual complement of bench and hand tools for servicing.
(b) Tube Checker.
(c) High Resistance Voltmeter -- 1000 ohms or more per volt
Ranges: 0-2.5, 0-10 and 0-100 volts
(d) Frequency Meter, 30 to 40 Megacycles, or USFS Type A Test Set, Calibrated.

General Procedure

Due to the simplicity of the circuit and the small number of parts, repairs to the Type S Radiophone are rarely necessary. In case of failure or damage, proceed as follows:

1. Check battery voltages. Batteries should be discarded if they fall below the following voltages under load; i.e., with the switch in "TRANS" position.

Battery	Nominal Volts	Low Limit
A Battery	3.0	2.5
B Battery	45	30
C Battery	7.5	7.0

2. Check tubes. This may be done also by trying the tubes in a set known to be in working order. Work the tubes in and out of the socket a few times.

3. Look for loose or corroded connections.

4. Inspect contacts of switch SW1. See that they are clean and adjusted to make firm connection.

5. Make mechanical inspection, to see that no parts are shifted from their proper locations.

6. Check transformers. Resistances should measure approximately the same as specified on Photodiagram (2.63).

7. Current measured in the B+ lead should show approximately 21 ma on transmit, and 11 ma on receive. These values may vary as much as 20% in a normal set and depend somewhat on the frequency to which it is tuned. (Currents measured with antenna attached.)

8. If the above does not reveal the trouble, a systematic check of parts may be made with the aid of the Parts List (2.5), the Schematic Diagram (2.62), and the Photodiagram (2.63).

2.1 Transmitter and Receiver

Frequency Setting

The Type S is adjusted at the factory to cover the range from 32 to 39 megacycles, in accordance with frequency allocations at the date of manufacture. If capacitor C1 or coils L1 or L2 have been bent or moved, this range should be checked.

Make no changes unless certain that the set is actually out of adjustment. Make all changes by small amounts so that it is easy to see whether a change is made in the right direction.

1. Connect set to batteries, and put switch SW1 in "TRANS" position.

2. Set Type A Test-Set or frequency meter at 39 megacycles.

3. Set dial to 100 (capacity at minimum, or plates completely unmeshed).

4. Carefully stretch or compress the tuning coil L1-L2 lengthwise until resonance is indicated at 39 megacycles. Compressing the coil will decrease the frequency, and stretching the coil will increase the frequency for a given setting of the tuning capacitor.

5. Set Type A Test-Set or frequency meter to 32 megacycles and tuning dial to 0 (plates of capacitor fully meshed).

6. Bend the plates of the tuning capacitor until the circuit is in resonance at 32 megacycles, as indicated by the frequency meter. The plates of the tuning capacitor must be fully unmeshed in order to reach them for bending and the tuning dial again turned to 0 after each trial. Be careful not to allow the rotor plates to come in contact with the stator plates. Contact between the rotor and stator plates will ruin oscillator tube VT-1.

Increasing the spacing of the plates of the capacitor will increase the frequency, and decreasing of the spacing of the plates will decrease the frequency.

7. Recheck at 39 megacycles. This setting will usually be very nearly correct, because the bending of the plates has relatively little effect on the capacity when the plates are unmeshed.

This procedure will put the set in its operating range within the limits required for this type of service.

2.5 Parts List

2.51 Capacitors

C1 **Variable Hammarlund Type SM-15**

C2 .00025 MFD. Fixed Mica Aerovox Type 1468, or Solar Type MO, or Equivalent

C3 .002 " " " " " 1467, " " " MW, " "

C4 .004 " " " " " 1467, " " " MW, " "

C5 .002 " " " " " 1467, " " " MW, " "

C6 .05 " " Paper " " 484, " " "S-0228, " "
C7 .0005 " " mica " " 1466, " " "MT-1322

2.52 Inductors

L1 8 Turns #14 AWG Enamel Wire, 5/8" inside Dia. x 7/8" Long,
Self-Supporting.

L2 Identical with L1

RFC Ohmite Type Z-1

2.53 Resistors

R1 Transmitting Grid Leak 10000 Ohms ½ watt IRC type BT or equivalent

R2 Receiving " " 100000 " ½ " " " BT " "

R3 Filament Dropping 4 " Special Spokane Radio Type S

2.54 Tubes

VT1 Type 30, RCA, Sylvania, or equivalent

VT2 Type 49, " " " "

2.55 Transformers

T1 Microphone and 1st A.F. Phelps-Dodge, Inca Type 02426

T2 Output and modulation " " " " 02428

2.56 Switches

SW1 4 Pole Double Throw, Federal Anti-Capacity

2.58 Batteries

1	Normal-duty "A"	General	4H2
		Eveready	X-248 or 723
		Burgess	2F2H
2	Normal-duty "B"	General	V-30-AA-2 (<u>not</u> V-30-AA)
		Burgess	Z-30-N
1	Lightweight "A"	General	2F2
		Eveready	X-212 or 722
		Burgess	F2BP
2	Lightweight "B"	Burgess	X-30-BP
1	"C"	General	V-5-PW
		Burgess	W-5-BP

Note: Either "Normal-duty" or "Lightweight" A and B batteries listed above are required, but not both.

2.59 Miscellaneous

1 Microphone Stromberg-Carlson Type 24562 and W.E. Type 247808
Western Electric Type F-1 with special case Phenol Fibre Lid used used in serial Nos. S-740 and higher.

1 Case, Microphone, for above microphone, Spokane Radio.

1 Cord, Microphone, 18" Collyer Ripcord.

1 Socket, 5-Prong Linen Bakelite Wafer Type; Bud, Cinch, or Equivalent.

1 " 4-Prong National Type XC-4 " " " "

1 Pr. Headphones, Trimm 2000 Ohms, Type F-100, with USFS Type Metal Headband.

1 Coupling, Shaft, ARHCo. Type 50-50C.

1 Post, Binding, "X-L" Push-Post, Marked "ANT," X-L Mfg. Co.

1 Cabinet and Cabinet Hardware. Re-order as required from local cabinet shop or hardware store.

1 Knob, Tuning for $\frac{1}{4}$" Shaft, Bud or Equivalent.

1 Wire, Antenna, 14 ft. 10 in. flexible braid covered, Lenz stranded, "Lenzac" or equivalent.

1 Halyard, Antenna, 15 ft. 2/o trolling line.

1 Insulator, Antenna, Johnson 32

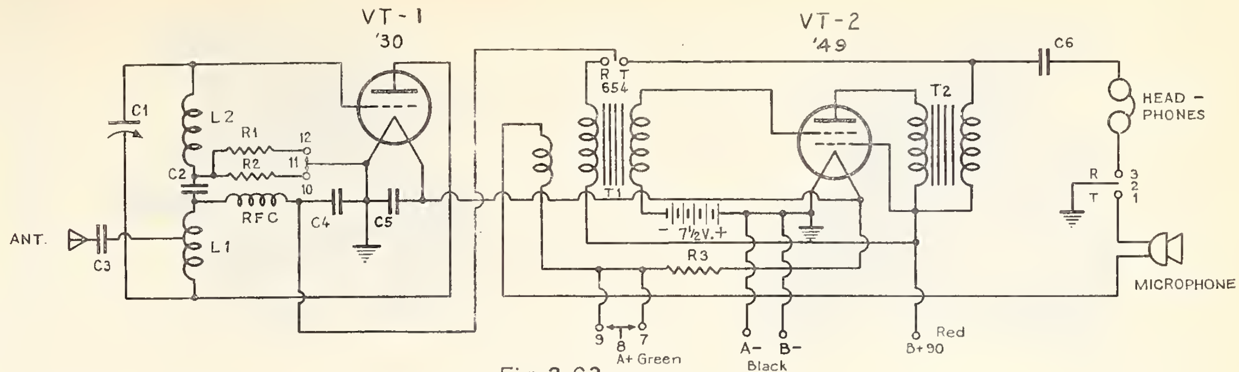
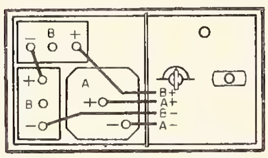
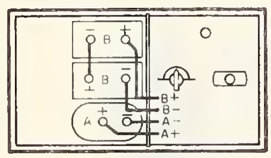


Fig. 2.62
Complete Circuit Diagram



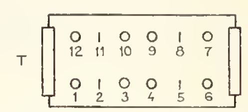
HEAVY DUTY BATTERY CONNECTIONS



LIGHT WEIGHT BATTERY CONNECTIONS

ARRANGEMENT OF BATTERIES

SW 1



Rear view of Federal Switch Numbers are same as shown in diagram.

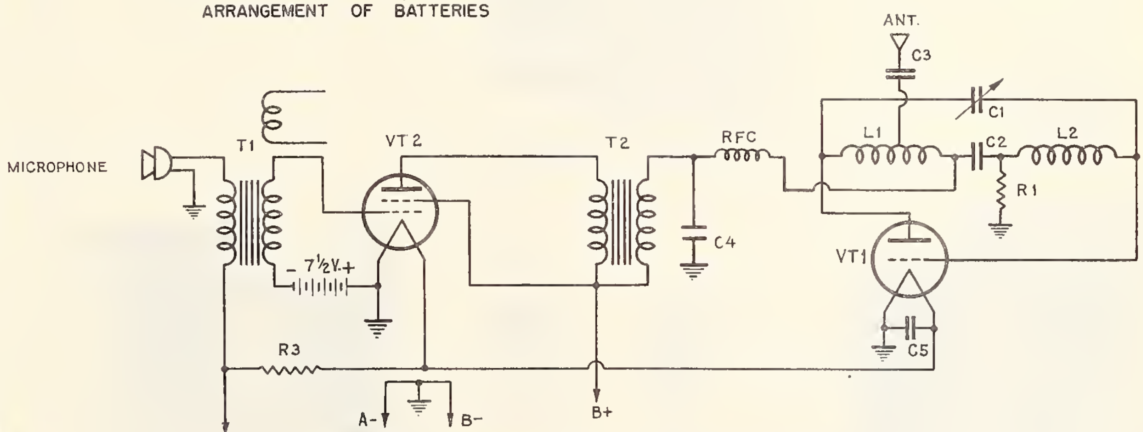


Fig. 1.1
Effective Circuit - Transmitting

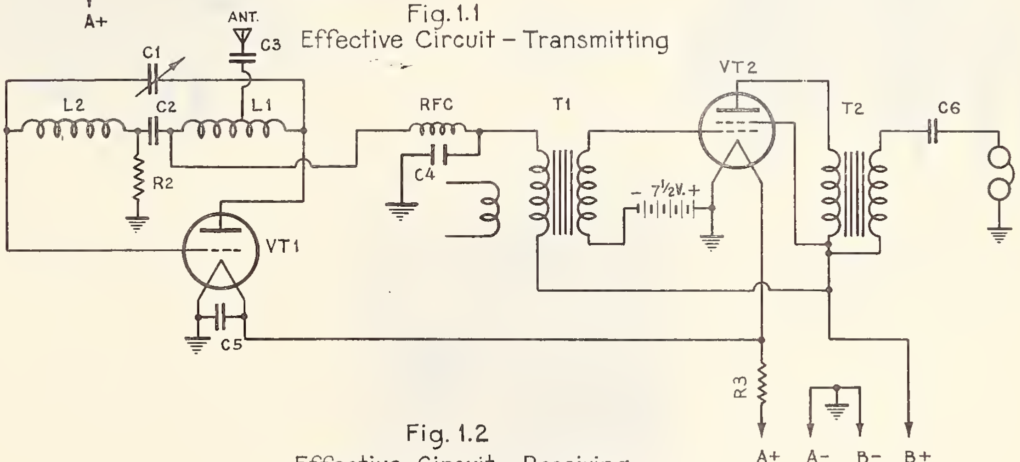


Fig. 1.2
Effective Circuit - Receiving

RADIO HDBK.

REVISION 6-5-39 DRAWN BY GVW. CHECKED BY E.H.S.

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE S RADIOPHONE
MODEL A

DESIGNED & CKD BY
DRAWN BY D.L.S.
APPROVED BY
DATE JUNE 7, 1937

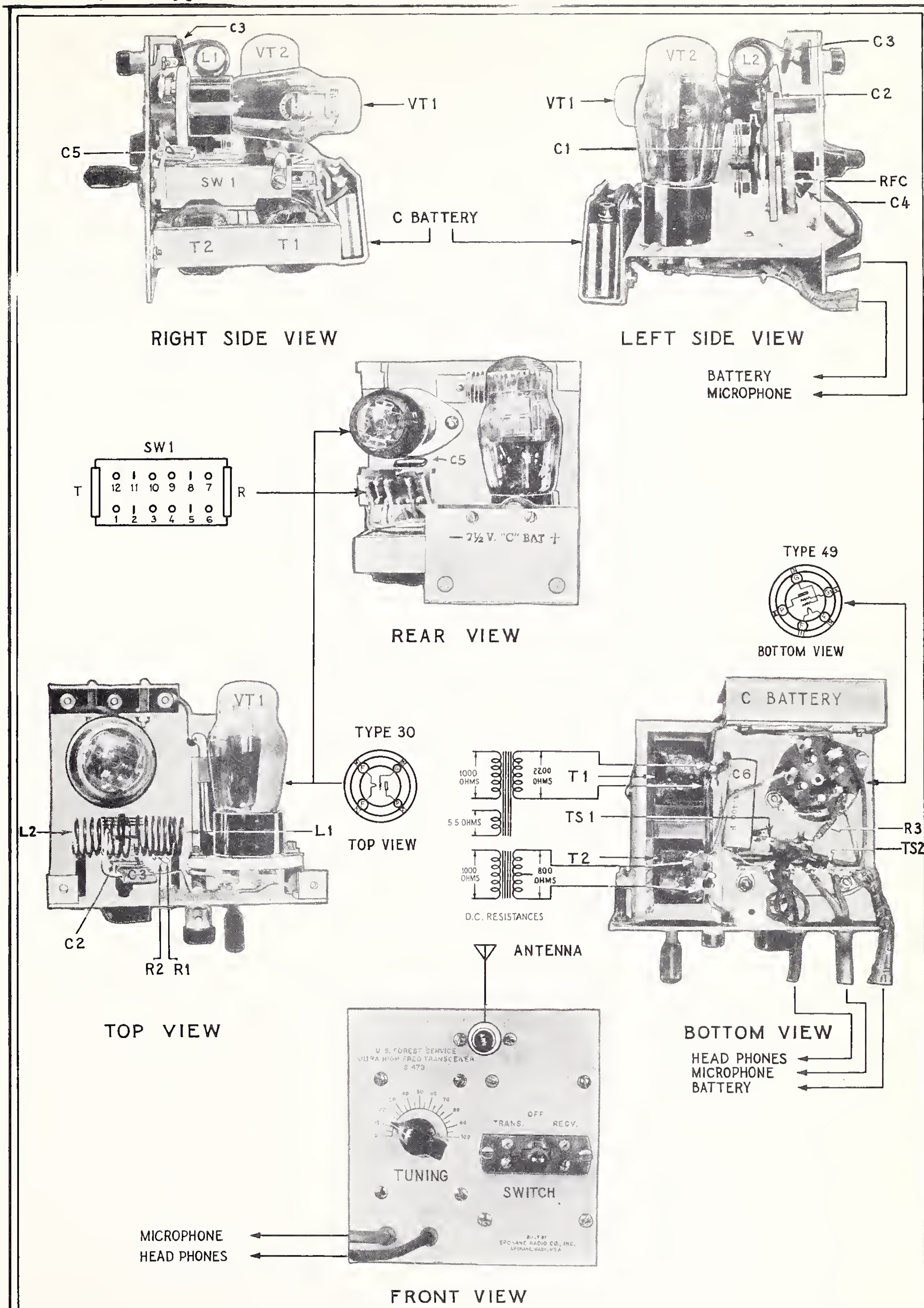


FIG. 2.63

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE S RADIOPHONE
MODEL A
DESIGNED & CKD. BY
DRAWN BY D.L.S.
APPROVED BY
DATE JUNE 15, 1937

C13.6 Service Data Sheets

Type SV

Model A Nos. 1 to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Model Nos. to Inc.

Note: For operating information see "Instructions for Operating," furnished with radio set.

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0.0 Description, General

The Type SV Radiophone operates in the frequency range 32 to 39 megacycles. Voice operation only is provided. Transmission and reception do not take place simultaneously, but alternately. A maximum range of 75 miles may be realized by optical path. The working range with the antenna close to the ground and over level terrain may be reduced to less than 2 miles.

The Type SV has been made available for applications in which the extreme portability of the Type S is not essential, and in which improved performance is required. The Type SV is superior to the Type S in the following respects:

1. Increased transmitter power, with more complete modulation is provided.

2. Improved receiver performance, with built-in loudspeaker is provided.

3. The Type SV transmitter and receiver have separate oscillator circuits and tubes; hence tuning the receiver does not affect transmitter frequency. This provides several advantages, among which is the ability to transmit and receive on different frequencies.

The features of the Type SV are its moderately high portability, the ease with which it can be set up and operated, and its application to use aboard moving vehicles.

0.1 Electrical Specifications

Frequency Range	32 to 39 Megacycles
Frequency Control	Self-Oscillator
Distance Range	Optical Path
Type of Transmission	Simplex Voice
Power Supply	Dry Batteries
Antenna	3/4 Wave Single Wire
Voice Input	Hand Microphone
Voice Output	Loudspeaker

Tube Complement	
	2 Type 31 Oscillator
	1 Type 1F5G Speech Amplifier and Audio
	1 Type 1H4G Detector
	1 Type 1H4G First Audio
	1 Type 1J6G Modulator
	1 Type 1D1 Receiver Ballast
	1 Type 1J1 Transmitter Ballast

0.2 Physical Specifications

The Type SV is housed in a plywood cabinet, which has a substantial full-sized carrying handle. The front cover is hinged in two places, such that it will fold flat against the right-hand side of the cabinet and be out of the way during periods of operation. The interior of the cabinet is divided into three compartments. The larger upper compartment contains the transmitter-receiver chassis. The lower right-hand compartment contains the batteries, which should be grouped as shown in the "Battery Compartment" sketch in Fig. 2.62. The rear of the lower left-hand compartment houses the speaker and its matching transformer. The space in front of the speaker contains the antenna and microphone when Radiophone is not in service.

Overall dimensions of the Type SV, when closed, are:

Height	$12\frac{1}{2}$ inches
Width	$12\frac{1}{4}$ "
Depth	7 "

The total weight of the Type SV is 18 pounds, 9 ounces. This is distributed as follows:

Cabinet	5 lbs.	11 oz.
Chassis and microphone	6	3
Batteries and battery cable	5	3
Speaker assembly	1	4
Antenna	0	4
Total	18 lbs.	9 oz.

1.0 Detailed Description

The Type SV was developed to meet a need for higher power and better operating characteristics than are available in the Type S. These features are obtained at the expense of added weight and size, so that the Type SV does not provide the extreme portability of the Type S.

In the Type SV, the carrier power has been increased to one watt, as compared with one-tenth watt in the Type S. The audio power has also been increased, resulting in an increase in the degree of modulation. The receiver has been made more sensitive, and has been provided with increased audio output, permitting the use of a loudspeaker instead of the headset.

In the Type SV, the transmitter and receiver have their separate r-f oscillator circuits and tubes, resulting in several operating and design advantages. Among the operating advantages may be listed the following:

(a) The transmitter and receiver may be operated on different frequencies, providing more liberty in the choice of operating procedures.

(b) In the Type S, which has a single r-f oscillator circuit and tube for both transmitter and receiver, transmitter operation takes place on a slightly different frequency from receiver operation, for a given dial setting. This has resulted in the necessity to re-tune at the start of each reception, at both stations which are in communication. The two stations, in thus following each other's frequency changes, will drift across a substantial portion of the band during a contact. The use of separate r-f oscillator sections for transmitter and receiver in the Type SV eliminates this trouble.

Among the design advantages may be listed the fact that in the Type SV it is possible to build each r-f oscillator section for best performance as a transmitter or as a receiver, instead of effecting a compromise, with attendant sacrifice in performance in both transmitter and receiver.

1.1 Transmitter Circuit

Fig. 2.62 shows the complete Schematic Diagram for the Type SV Radiophone.

The Schematic Diagram for the transmitter section only is shown on the same sheet, as Fig. 1.11. Referring to the r-f oscillator section of Fig. 1.11, Cgf and Cpf are the grid-filament and plate-filament capacitances within the Type 31 tubes. These capacitances contribute a sizable fraction of the total tuned circuit capacitance, and have the additional important effect of determining the ground point on the tuned circuit. The oscillator circuit is thus seen to be a type of Colpitts oscillator. Capacitance C6 is a blocking capacitor, which isolates d-c plate and grid voltages. D-c and modulation-frequency plate voltage is fed to the tubes through RFC2, an r-f choke, and L5. Inclusion of RFC2

is necessary to prevent a second r-f ground on the tuned circuit, in addition to that provided by Cgf and Cpf. R2 is the grid leak. The grid condenser consists of Cgf in parallel with the series combination of C6 and C7. C8 is a filament bypass capacitor.

Referring to the audio amplifier, the microphone transformer T2 excites the 1F5G voltage amplifier, which drives the 1J6G Class B modulator. The plate current to the two Type 31 oscillator tubes flows through the secondary of the modulation transformer, T4. The audio voltage induced in the secondary of T4 is thus connected in series with the d-c voltage to the oscillators, and plate modulation is thereby effected.

1.2 Receiver Circuit

The Schematic Diagram for the receiver section only is shown in Fig. 1.21. The receiver is a self-quenching super-regenerator with 2 stages of audio amplification. It will be noted that the oscillator portion of the circuit is nearly identical with the oscillator portion of Fig. 1.11, and the same remarks that were made for the oscillator portion of the transmitter apply here. The quenching is provided by proper proportioning of the grid leak and grid condenser values. Intensity of oscillation is controlled by variation of oscillator plate voltage, which is accomplished by means of R3.

The resistance-capacity filter preceding the grid of the 1H4G audio amplifier tube is to keep the interruption frequency voltage out of the tube, and thereby prevent overloading. The loudspeaker is operated through its matching transformer from the output of the 1F5G second audio tube.

1.4 Switching Circuits

Manipulation of the anti-capacity switch, SW1, selects transmitter or receiver operation, or turns the Radiophone off. SW1 switches antenna, filaments, ballast tubes, microphone, and speaker, as can be seen from Fig. 2.62.

(*) 1.5 Other Features

1.51 Antenna

The Type SV normally uses a 3/4-wave antenna. For components and dimensions, see 2.5, Parts List.

Where conditions permit, improved performance can be obtained with a Type J antenna. See Sec. C9.203, "Type J Antennas, 30 Mc" for details of antenna construction, adjustment, and installation.

The procedure for connecting the antenna and resonating the transmitter is outlined below:

1. Disconnect short flexible ground wire from right-hand binding post.

2. Connect the two wires at the end of the rubber-covered cord to the two "ANT" posts on the panel. Be sure that the uninsulated part of these wires does not touch the metal panel.

3. Set the Type A test set in operation as a grid-dip oscillator (See Sec. C12.301, "Type A Test Set", Item 1.2) and adjust the test-set dial to indicate the frequency to which the antenna is resonant.

4. Turn "TRANS-RECV" switch on radiophone panel to "TRANS".

5. With the coil of the test set in proximity with the rubber-covered antenna cord, adjust the "TRANS TUNE" knob until a sharp upward deflection of the test-set meter indicates the radiophone transmitter resonates with the test-set frequency. (See Sec. C12.301, "Type A Test Set", Item 2.03).

2.0 Adjustment and Repair, General

The following tools and equipment should be on hand for adjusting the Type SV Radiophone:

(a) Usual complement of bench and hand tools for servicing.

(b) Tube Checker.

(c) Combination Ohmmeter - High Resistance Voltmeter-Milliammeter;
(*) 1000 ohms or more per volt. Scales needed, 0-2.5, 0-10, 0-50, 0-250 volts; 0-10, 0-100 ma.

(d) Frequency or Wave Meter, Range 30 to 40 Megacycles; or USFS Type A Test Set, Calibrated; or Absorption Type Wavemeter.

Routine checks of tubes and batteries should be made periodically. Batteries should be discarded if their voltages fall below the Low Limits tabulated below. Voltage should be measured with the batteries connected to the Radiophone, and the switch in the "TRANS" position. Let the Radiophone operate with the switch in the "TRANS" position for a half-minute before taking the readings. Access to the "C" battery is gained by removing the bakelite name plate from the front panel.

Battery	(*) Nominal Volts	(*) Low Limit
A-Battery	3	2.5
B-Battery	45	34
C-Battery	4.5	4.2

Due to the simplicity of the circuit, repairs to the Type SV Radiophone are rarely necessary. In case of damage or failure to operate properly, remove chassis from cabinet. Check batteries and tubes, as stated above, and work the tubes up and down in their sockets a few times. If no tube checker is available, the tubes may be tried in another Type SV Radiophone known to be in good operating order. Examine the chassis carefully for broken leads, shorts, or other mechanical damage. Look for loose or corroded connections. Inspect contacts of the anti-capacity switch, and see that they are clean and adjusted to make firm connections. See that antenna coils L-3 and L-6 nest properly in the coil forms. See if turning the control of R3 introduces noise into the receiver. If so, R3 should be replaced. Check the transformers. Resistances should measure approximately the same as marked on the Photodiagram, Fig. 2.63. Check the wiring by use of Fig. 2.62.

With the switch in the "RECV" position, current in the +B 90-volt lead should be 5 ma, and in the +B 135-volt lead should be 11 ma. With the switch in "TRANS" position, current in the +B 90-volt lead should be zero, and in the +B 135-volt lead should range between 50 and 85 ma, from no modulation to full modulation.

2.1 Transmitter Data

The Type SV Radiophone is adjusted at the factory to cover the range from 32 to 39 megacycles, and can be expected to stay within this range during the life of the Radiophone, unless the tuning capacitor becomes altered.

Small changes in the frequency ranges covered can be effected by bending of the tuning condenser plates.

(*) Coupling coil L-6 should be inserted within the form for L-4 and L-5 to a position just inside the turns of the outer coil. This corresponds to fairly tight coupling, and the exact degree of coupling is not critical.

2.2 Receiver Data

The remarks made in Section 2.1 apply also to the frequency range of the receiver oscillator section. A trimmer in parallel with the tuning capacitor permits some adjustment of frequency band.

(*) The following procedure should be used to adjust the coupling of antenna coil L-3:

1. Connect the antenna wire to the left-hand "ANT" post. Turn "TRANS-RECV" switch to "RECV".

2. On turning the "SENSITIVITY" knob from the extreme left-hand position toward the right, a point will be found where the characteristic hiss of the super-regenerative receiver is supplemented by a high-pitched howl, or squeal. The exact setting of the "SENSITIVITY" knob to produce this squeal depends somewhat on the setting of the "RECV-TUNE" knob. Adjust the "SENSITIVITY" knob as far to the right as possible without producing this squeal for any setting of the "RECV-TUNE" knob.

3. With the "SENSITIVITY" knob left as adjusted above, adjust coupling of antenna coil L-3 as close as possible without producing a dead spot on the receiver tuning range. Such a dead spot will be evident as a portion of the tuning range over which the characteristic receiver hiss is not heard.

2.3 Power Supply Data

Batteries required by the Type SV Radiophone are listed under <u>2.58 Batteries</u>.

These are installed and connected as shown in the "Battery Compartment" sketch of Fig. 2.62. Current drains are as follows:

Battery Connection	Transmit	Receive
A	670 ma.	240 ma.
+ 90-volt B	0	5
+ 135-volt B	50 to 85	11

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Receiver Tuning, Variable	Standard, Reduced to 11 Plates	Hammarlund	HF-30-X
C2	Plate Blocking, Receiver	.001 MFD. Mica	(Aerovox (Solar	1467) or MW)equiv.
C3	Plate Bypass, Receiver	.003 " "	(Aerovox (Solar	1467) MW) "
C4	Filament Bypass, Receiver	.002 " "	(Aerovox (Solar	1467) MW) "
C5	Transmitter Tuning, Variable	Standard, Reduced to 15 Plates	Hammarlund	HF-30-X
C6	Plate Blocking, Transmitter	.00025 MFD. Mica	(Aerovox (Solar	1467) or MW)equiv.
C7	Plate Bypass, Transmitter	.002 " "	(Aerovox (Solar	1467) " MW)
C8	Filament Bypass, Transmitter	.002 " "	(Aerovox (Solar	1467) " MW
C9	R-f Filter	.0001 " "	(Aerovox (Solar	1468) " MO)
C10	" "	Identical with C9		
C11	" "	" " "		
C12	" "	" " "		
C13	Speaker Blocking	.25 MFD., 400-Volt	(Aerovox (Solar	484) " S-0256)
C14	Plate Bypass	.25 " 200-Volt	(Aerovox (Solar	284) S-0245) "
C15	**Plate Bypass**	10 mfd. 150V Electrolytic	Mallory	BB-22 *
C16	Microphone Bypass	.0005 mfd. mica	(Aerovox (Solar	1465) MT-1322)
C17	Trimmer	30 mmf mica trimmer	National	M-30

*If this make is not available for replacement, the equivalent capacitor selected must have suitably low leakage current.

2.52 Inductors

SYMBOL	DESCRIPTION		
L1 and L2	Receiver oscillator coils. Both are wound on a single National Type XR-3 Form, 9/16" Dia. x 3/4" long. Each coil consists of 4 turns of #26 A.W.G. enamel wire, space wound so as to have a length of 5/32". Separation of L1 and L2 is 5/64".		
L3	Receiver antenna coil. 2 turns #20 A.W.G. D.S.C. wire, self-supporting, wound on 3/8" form, inserted inside coil form for L1 and L2.		
L4 and L5	Transmitter oscillator coils. Both are wound on a single National Type XR-3 Form, 9/16" Dia. x 3/4" long. Each coil consists in 4 turns of #26 A.W.G. enamel wire, space wound so as to have a length of ¼". Separation between L4 and L5 is 3/32".		
L6	Identical with L3, inserted inside coil form for L4 and L5.		
RFC1	Receiver Choke	(Ohmite (Coto	Type Z-1) Type C1-13)
RFC2	Transmitter Choke	(Ohmite (Coto	Type Z-1) Type C1-13)

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R1	Grid Leak, Receiver	75,000 Ohms, ½ Watt	IRC	BT½
R2	Grid Leak, Transmitter	10,000 " 1 "	IRC	BT1
R3	Sensitivity Control	100,000 " Variable Tapered	IRC	11-128
R4	R-f Filter	100,000 Ohms, ½ Watt	IRC	BT½
R5	" "	Identical with R4		
R6	" "	" " "		
R7	" "	" " "		
R8	Microphone Shunt	100 Ohms, ½ Watt	IRC	BT½
R9	Audio Loading	40,000 Ohms, ½ Watt	IRC	BT½

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT1	Oscillator, Receiver	Sylvania, or Equivalent	1H4G
VT2	Oscillator, Transmitter	" " "	31
VT3	" "	" " "	31
VT4	Audio Amplifier	" " "	1H4G
VT5	Audio Amplifier	" " "	1F5G
VT6	Modulator	" " "	1J6G
VT7	Ballast	Sylvania	1J1
VT8	Ballast	"	1D1

2.55 Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T1	Receiver Input	Phelps-Dodge	INCA 02425
T2	Microphone, Receiver Interstage	" "	INCA 02426
T3	Class B Input	" "	INCA 04792
T4	Modulation	" "	INCA 06066
	Speaker Matching	Oxford	21-A-162

2.56 Switches

SW1 Anti-Capacity 4-Pole Double Throw Federal

2.58 Batteries

QUANTITY	USE	MANUFACTURER	TYPE
1	"A" Battery	General Eveready Burgess	4H2 X-248 or 723 2F2H
3	"B" Batteries	General Burgess	V-30-AA-2 (not V-30-AA) Z-30-N
1	"C" Battery	General Burgess	H-3-AF A-3-BPX or A-3-BP

and W.E. Type 247808 phenol fibre glued used in

2.59 Miscellaneous

Microphone	Stromberg-Carlson Type 24562 Western Electric Type F-1 with special case ~~on~~ serial Nos. SV-170 and higher.
Case, Microphone	Radio Spec. Type SV
Cord, Microphone	24" Collyer 2-conductor rubber covered flexible cord or equivalent.
Speaker	3" Perm. Mag. Dynamic Oxford Type 3 AMP
Cord, Speaker	8" Collyer 2-conductor rubber covered flexible cord, or equivalent fitted with phone tip plugs.
Jack, Speaker	Mallory-Yaxley Moulded Twin-Tip Jack Type No. 432.
Jack, Battery	Jones type PM-5C with bevel for 1/16" with nut and bakelite back piece.
Plug, Battery	Jones std. 5-prong plug for PM-5C socket, with rubber sleeve.
Cable, Battery	12" 5-conductor cable, flexible braid covered, fitted with aluminum terminal markers and terminals for binding posts. Lenz 5-conductor battery cable per Lenz shop order ~~[illegible]~~ 98304 mfd for U. S. Dept. Agri., Forest Service.
Dial Plates, 2 Req.	Crowe Type 550, 0-100 reading left to right.
Knobs, 3 Req.	Bud Type 575
Sockets, 2 Req.	National 4-prong Ceramic.
Sockets, 2 Req.	National Octal Base Ceramic.
Sockets, 2 Req.	Cinch Octal Base Linen-Bakelite Wafer, Type O 15.
Sockets, 2 Req.	Cinch 4-prong Linen Bakelite, Type X15.
Posts, Binding	"X-L" Push-Post, Marked **"ANT."**

Coupling, Condenser Shaft, 2 Req., ARHCO Type 50-50C.

Cabinet and Cabinet Hardware: Re-order as required from local cabinet shop or hardware store.

Wire, Antenna	21 ft. 10 in. #20 flexible braid covered, Lenz stranded "Lenzac" or equivalent.
Halyard, Antenna	20 ft. 2/o trolling line.
Insulator, Antenna	Johnson Type 32.

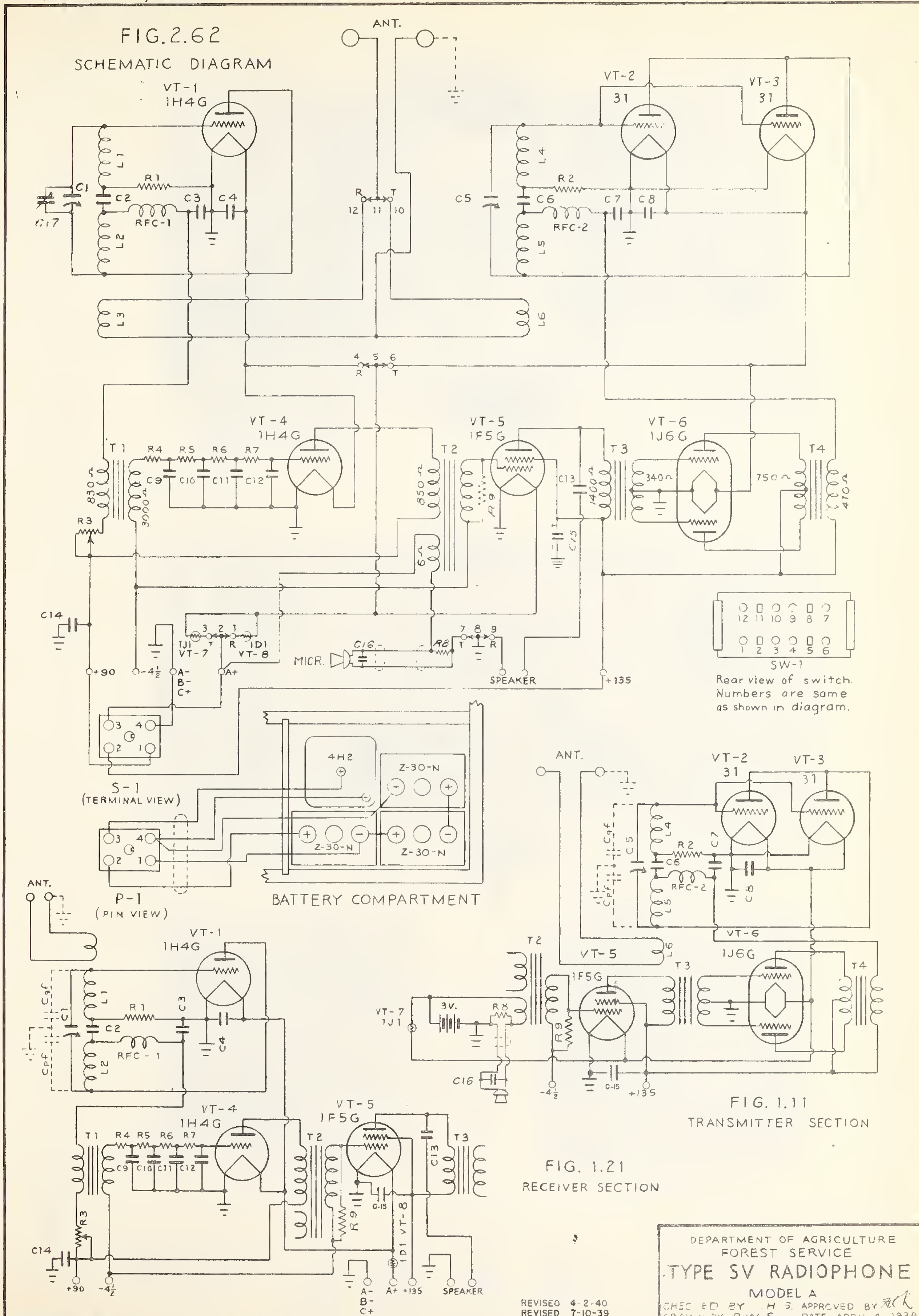
FIG. 2.62
SCHEMATIC DIAGRAM
ANT.
VT-1 1H4G
VT-2 31
VT-3 31
VT-4 1H4G
VT-5 1F5G
VT-6 1J6G
MICR.
SPEAKER
+90
-4½
A- B- C+
A+
+135
SW-1
Rear view of switch. Numbers are same as shown in diagram.
S-1 (TERMINAL VIEW)
P-1 (PIN VIEW)
4H2
Z-30-N
BATTERY COMPARTMENT
FIG. 1.11
TRANSMITTER SECTION
FIG. 1.21
RECEIVER SECTION
DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE SV RADIOPHONE
MODEL A
DRAWN BY P. W. S.
DATE - APRIL 4, 1938
REVISED 4-2-40
REVISED 7-10-39

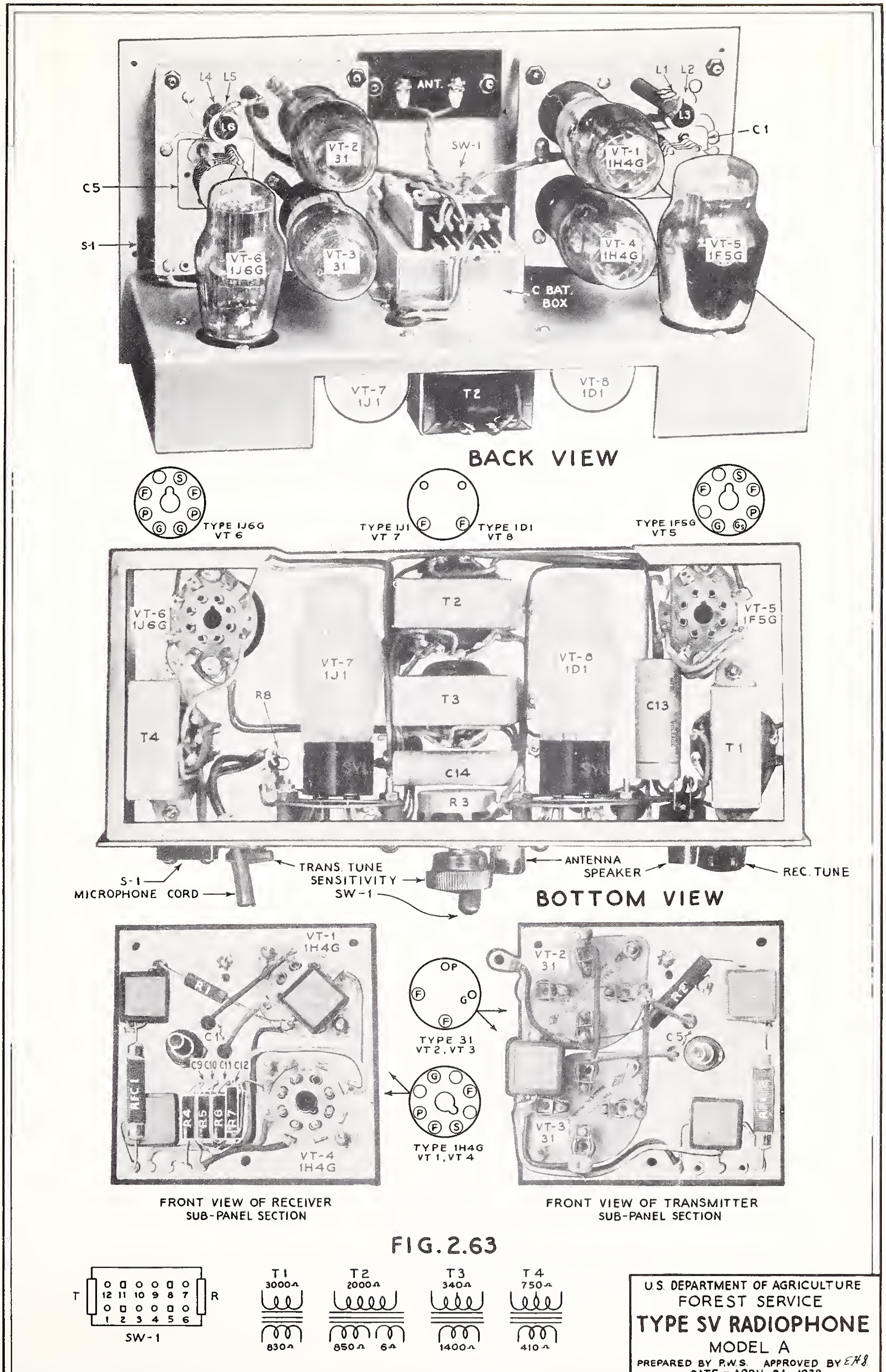
L4 L5
L6
ANT.
L1 L2
L3
C1
VT-2
31
SW-1
VT-1
1H4G
C5
S-1
VT-6
1J6G
VT-3
31
VT-4
1H4G
VT-5
1F5G
C BAT.
BOX
VT-7
1J1
T2
VT-8
1D1
BACK VIEW
TYPE 1J6G
VT 6
TYPE 1J1
VT 7
TYPE 1D1
VT 8
TYPE 1F5G
VT5
VT-6
1J6G
VT-7
1J1
T2
T3
VT-8
1D1
VT-5
1F5G
R8
C13
T4
C14
R3
T1
TRANS. TUNE
SENSITIVITY
SW-1
S-1
MICROPHONE CORD
ANTENNA
SPEAKER
REC. TUNE
BOTTOM VIEW
VT-1
1H4G
R1
C1
C9 C10 C11 C12
RFC1
R4 R5 R6 R7
VT-4
1H4G
TYPE 31
VT 2, VT 3
TYPE 1H4G
VT 1, VT 4
VT-2
31
R2
C5
VT-3
31
FRONT VIEW OF RECEIVER
SUB-PANEL SECTION
FRONT VIEW OF TRANSMITTER
SUB-PANEL SECTION
T
R
12 11 10 9 8 7
1 2 3 4 5 6
SW-1
T1
3000Ω
830Ω
T2
2000Ω
850Ω 6Ω
T3
340Ω
1400Ω
T4
750Ω
410Ω
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE SV RADIOPHONE
MODEL A
PREPARED BY P.W.S. APPROVED BY E.H.G.
DATE - APRIL 21, 1938

FIG. 2.63

2.7 Additional Data

2.71 Addition of Plate Battery Bypass Capacitor
(Serial numbers SV-63 and lower)

Field use of the Type SV radiophone, Model A, has revealed a condition of faulty operation which appears when the batteries approach the end of their useful life. The trouble manifests itself in the form of an audio-frequency tone, or howl. This tone may appear on "TRANSMIT", or "RECEIVE", or both. Its cause is coupling between output and input of the a-f amplifier section of the radiophone, which permits the amplifier to oscillate. The coupling is due to the fact that the increased internal resistance of the battery is common to both input and output circuits.

The remedy is the bypassing of the plate battery with a relatively large capacitor. An electrolytic capacitor is required to get the necessary capacitance in a reasonable physical size. All electrolytic capacitors have some leakage current, and since it is not feasible to switch the voltage off the bypass capacitor by merely throwing the changeover switch to "OFF", it is necessary to select a capacitor with low leakage current, such as the Mallory Type BB-22.

Fig. 2.71 shows the details of installation for this bypass (C-15). C-15 is factory installed on Type SV radiophones with serial numbers above SV-63, and should be installed by field technicians on all sets whose number is SV-63 and lower. The positive lead of C-15 should be covered with insulating tubing and should be sufficiently free of slack so it will not rub against the case of transformer T-1.

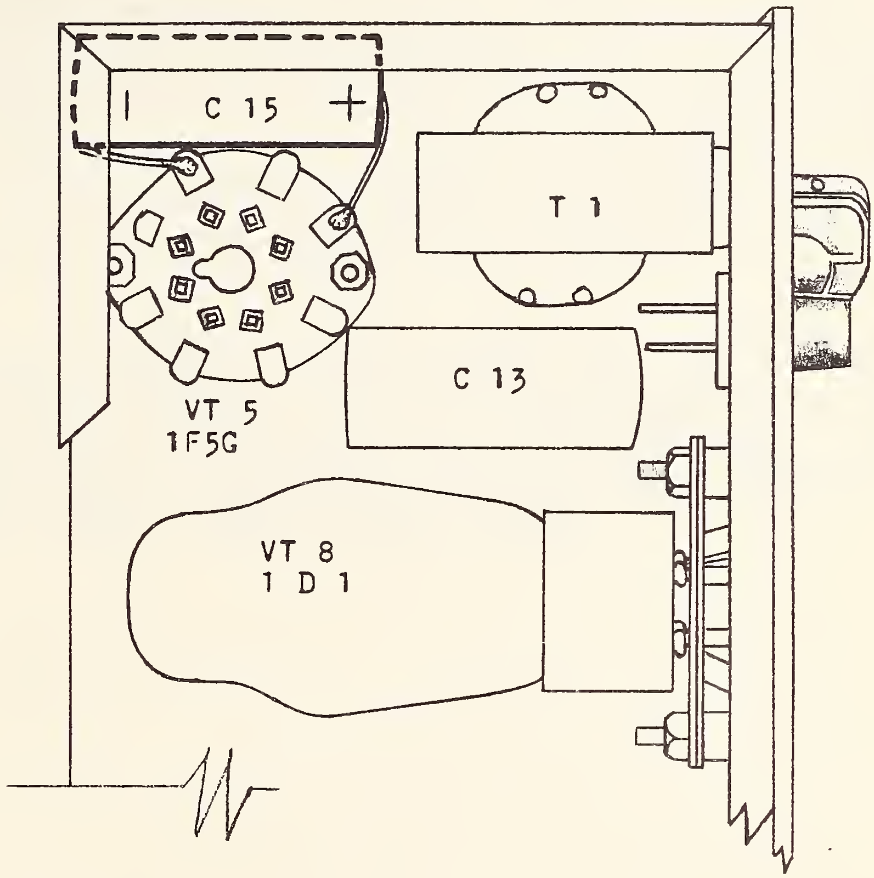

FIG. 2.71 SKETCH SHOWING INSTALLATION OF C-15

2.72 Change in Microphone-Supply Wiring
(Serial numbers SV-166 and lower)

The Type SV radiophone is frequently used with heavy-duty batteries, stored outside the cabinet. Occasionally trouble has been experienced when the grounded metallic part of the microphone case has accidentally been allowed to contact one of the "B" battery terminals. If this occurs when the "TRANS-RECV" switch is thrown to "TRANS", the only harmful result is a heavy drain on the "B" battery during the time the accidental contact exists. However if the "TRANS-RECV" switch is "OFF", "B" battery voltage is applied to the filament of audio amplifier VT-5, resulting in the burning out of this tube. If the "TRANS-RECV" switch is thrown to "RECV", all of the tubes in the receiver section, VT-1, VT-2, and VT-5 will be burned out.

A simple change in wiring is suggested which will eliminate the danger of burning out tubes from this cause. The microphone-supply wire is connected directly to the "A+" terminal, instead of being supplied through contacts on the "TRANS-RECV" switch. The grounded side of the microphone circuit is still switched by the changeover switch. Correct wiring is shown on Fig. 2.62, the Schematic Diagram, marked "revised 4-2-40".

C13.7 Service Data Sheets

Type T

Model	CA	Nos.	139	to	267	Inc.
Model	CB	Nos.	268 289	to	278 309	Inc.
Model	CC	Nos.	279	to	288	Inc.
Model	D	Nos.	310	to	397	Inc.
Model	DA	Nos.	398	to	411	Inc.
Model	DB	Nos.	412	to		Inc.

Note: For operating information see "Instructions for Operating," furnished with radio set.

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0.2 Physical Specifications

PART 1

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1.2 Receiver Circuit

1.3 Power Supply Circuit

1.4 Switching Circuits

1.5 Other Features

PART 2

2.0 Adjustment and Repair

2.1 Transmitter Data

2.2 Receiver Data

Models CA, CB, and CC

Models CA and CB can be operated either simplex or duplex. Model CC has no provision for duplex operation.

The transmitter portions of Models CA, CB, and CC are identical. The receiver of Model CA differs from that of Models CB and CC, as explained in detail in the Service Data Sheets.

0.0 General Description

The Type T Radiophone is a battery operated transmitter-receiver, which operates in the frequency range 30 to 40 megacycles. Transmission and reception of voice only is provided. The Type T will communicate with other radiophones of Types S, SV, T, and U. In general, communication is limited to paths between points which are intervisible. A distance range of as much as 200 miles may be realized under conditions where optical paths exist. With a low antenna over flat terrain, this range may be reduced to 2 miles.

The Type T is intended primarily for use at lookout towers. Each National Forest is assigned two frequencies for use by Type T equipment. A Forest may order one-half of its Type T Radiophones to transmit on the higher frequency (serial numbers preceded by "TH"), and one-half to transmit on the lower frequency (serial number preceded by "TL"). The radiophones are so distributed that a "TH" radiophone normally communicates with a "TL." Under these conditions duplex operation may be employed, except with model CC, in which no provision is made for duplex operation. Simplex operation only is possible between two Types "TL" or two Types "TH." Simplex operation only is possible between a Type T and a Type S or SV.

Provision is made to connect the Type T Radiophone to a telephone line, so that the telephone subscriber at the distant end of the line can talk directly with the operator at the distant end of the radio link. The attention of the operator at the radiophone where the Type T connects with the telephone line is engaged briefly only when the connection is established and when it is concluded. With the connection to the telephone line, duplex operation is provided only when one Type "TL" and one Type "TH" radiophones form the two ends of the radio link.

For installations where conditions of intervisibility are met, use of the Type T is particularly advantageous. During lightning storms when the fire hazard is especially high, atmospheric disturbances of such severity as to render a telephone or medium-high frequency radio link useless usually do not impair the operation of the ultra-high frequency Type T Radiophone.

A telephone type handset is supplied. In addition, a speaker built into the front panel provides convenient means for standing by on a particular frequency on which calls are expected.

0.1 Electrical Specifications

Frequency	30 to 40 Megacycles
Frequency Control	Self-excited Oscillator
Power Output	$2\frac{1}{4}$ Watts
Distance Range	Optical Path
Types Operation	Duplex Voice Simplex Voice Duplex or simplex voice with telephone line connection
Power Supply	Dry Batteries
Input	Handset Microphone
Output	Handset Receiver or Speaker
Tube Complement	1 Type 31 Oscillator 1 Type 49 Doubler 1 Type 19 Final Amplifier 1 Type 1F4 Speech Amplifier 1 Type 19 Modulator 1 Type 1F4 Audio Amplifier 1 Type 1D7G Detector (in Models CB and CC) 1 Type 34 R-F Amplifier (in Model CA) 1 Type 19 Detector (in Model CA)
Antennas	1 Half-wave Doublet tuned to higher frequency forest assignment 1 Half-wave Doublet tuned to lower frequency forest assignment

0.2 Physical Specifications

Radiophone dimensions	15" wide x 21-3/4" high x 9¼" deep
Radiophone weight, including handset, cables, but not batteries nor antenna	29 pounds

1.0 Detailed Description

The oscillator, doubler, and final amplifier portions of the transmitter are built into a unit sub-assembly, which is mounted on the rear of the panel, on the upper right-hand section as one faces the front of the panel. This sub-assembly has two decks, the lower of which holds the oscillator and doubler stages, while the upper deck holds the final amplifier.

The receiver, except for its audio amplifier, is housed in a unit sub-assembly, which mounts on the upper left-hand section of the panel. In the Model CA, this sub-assembly has two decks, the upper of which is the r-f amplifier stage, while the lower is the detector. In Models CB and CC, the receiver sub-assembly is a single deck structure, which is the detector.

Another chassis, mounted to the lower section of the panel, contains the receiver audio amplifier, transmitter speech amplifier and modulator, and terminal strips connecting to telephone line, battery cable, and handset cable.

The meter, meter switch, and changeover switch are mounted on the panel between the receiver and transmitter sub-assemblies. Speaker, filament rheostats, receiver volume, and receiver screen voltage controls are mounted on the lower section of the front panel.

Separate antenna terminals are brought out for the transmitter and receiver. Both pairs of terminals appear through ceramic insulators on the front panel.

Models CA, CB, and CC have identical transmitters. The receiver in Model CA differs from that of Models CB and CC. Models CB and CC differ only in that no provision is made for duplex operation in Model CC.

1.1 Transmitter Circuit

In the three Models CA, CB, and CC, a Type 31 oscillator excites a Type 49 doubler, which drives a Type 19 modulated final amplifier. A Type 1F4 speech amplifier drives a Type 19 modulator, which plate-modulates the Type 19 final amplifier.

Referring to Fig. 2.62, the Schematic Diagram for Model CB, it is seen that L-1 and C-1 form the Hartley oscillatory circuit for VT-1. This circuit is tuned such that VT-1 oscillates at one-half the transmitter frequency. R-1 is the oscillator grid leak, and C-3 the grid condenser. R-11 is a plate lead filter resistor, bypassed by C-2.

Doubler amplifier VT-2 is excited through coupling capacitor C-4. R-2 is the grid leak for VT-2. The tuned plate circuit for VT-2, consisting of L-3 and C-5, is tuned approximately to transmitter frequency. Plate voltage is fed to VT-2 through r-f choke RFC-1, bypassed by C-6.

Excitation for the final amplifier stage is accomplished through a link circuit, consisting of link coil L-5, which is coupled to L-3, and link coil L-6, which is coupled to L-7. A grounded twisted-pair transmission line connects L-5 and L-6.

L-7 and C-11 form the tuned input circuit to VT-3, the push-pull final amplifier tube. Since grid current in VT-3 is measured at some distance from the tuned circuit, a grid-return filter is provided, consisting of R-3 bypassed by C-10. C-12 and C-13 are neutralizing capacitors.

C-14 and L-8 form the tuned plate circuit for VT-3. Plate voltage is fed to VT-3 through the secondary of T-3, the modulation transformer, and RFC-2, an r-f choke. L-9, the antenna coil, is inductively coupled to L-8.

With the changeover switch SW-2 in "TRANSMIT" or "DUPLEX" position, and with the handset off the hook, the microphone is connected in series with the "A" battery and the primary of T-1, the microphone transformer. With the changeover switch in "TEL. LINE" position, voice input from the telephone line is applied directly to the primary of T-1, whether or not the handset is off the hook. The primary of T-1 is shielded electrostatically to prevent certain types of noise induced in telephone lines from being modulated on the transmitter.

Resistors R-5 and R-6 in series serve the dual purposes of loading the microphone transformer and providing a voltage divider for the input to speech amplifier VT-4. T-2 is the driver transformer for push-pull modulator VT-5. High-voltage supply to plate and screen of VT-4 is bypassed by C-15. Grid bias for both VT-4 and VT-5 comes from the $4\frac{1}{2}$ volt "C" battery.

The plate load for VT-5, the modulator, is the primary of T-3, the modulation transformer. The secondary of T-3 is in series with the plate supply for VT-3, the final amplifier. Voice-frequency voltage developed across the secondary of T-3 is thereby superimposed upon the d-c battery voltage, and plate modulation of VT-3 results.

1.2 Receiver Circuit

Models CB and CC

Referring to Fig. 2.62, the Schematic Diagram for Model CB, it is seen that the receiver consists of a 1D7G pentagrid detector tube with a single stage of audio amplification. Grids 1 and 2, the oscillator and anode grids of the pentagrid tube VT-101, together with their external circuit, generate oscillations at low interruption frequency. The anode grid intercepts only some of the electrons emitted from the filament, the remainder going through the other grids to the screen and plate. Thus a virtual cathode is formed between the number 3 screen grid and number 4 control grid. Due to the oscillations generated in grids 1 and 2, this virtual cathode is modulated at the low interruption frequency.

Since the virtual cathode has a physical location between number 4 control grid and number 3 screen grid, which is bypassed to ground by C-103, the capacitances between the virtual cathode and grids numbers 3 and 4 will cause the virtual cathode to acquire an r-f potential between that of the control grid and ground. Inspection of the circuit will reveal that with the r-f potential of the virtual cathode between grid and ground, an r-f oscillatory circuit exists, with screen grid number 5 serving as the grounded anode. Due to the fact that the intensity of the electron stream coming through screen grid number 3 is modulated at the low interruption frequency, the r-f oscillations will be intermittent, and will build up and collapse at the interruption frequency. The conditions necessary for super-regenerative detection are thus fulfilled.

L-101, the antenna coil, is inductively coupled to L-102, the r-f grid coil. L-102 is tuned to resonance by C-101. C-102 and R-101 are respectively the grid condenser and grid leak for the r-f oscillator portion of the detector.

L-103 and L-104 are respectively the grid and plate coils for the low interruption frequency oscillator. L-103 is tuned by capacitor C-105. C-104 and R-102 are respectively the grid condenser and grid leak for the low interruption frequency oscillator portion of the detector. R-103 is a filter resistor for the plate voltage supply to the anode grid. It is bypassed by C-106.

R-f chokes RFC-101 and RFC-102, together with capacitors C-107, C-108, and C-109, form a filter for the audio-frequency currents in the plate lead. This filter excludes r-f and interruption frequency currents from the input to the audio amplifier.

Detector screen voltage is controlled by potentiometer R-105. The audio output from the detector is impedance coupled to VT-102, the audio amplifier. An iron-cored choke, L-105, is the coupling impedance, while C-110 is the coupling capacitor. Grid voltage for VT-102 is taken from R-107, a potentiometer not controlled from the front panel. Grid bias for VT-102 comes from the $4\frac{1}{2}$-volt "C" battery. Plate voltage for VT-102 is bypassed by C-111.

T-101, the receiver output transformer, has two secondary windings, one for operating the speaker, and the other for operating the handset receiver or telephone line.

Model CA

In the Model CA, the receiver consists of a Type 34 r-f amplifier, a Type 19 superregenerative detector, and a Type 1F4 audio amplifier.

Referring to Fig. 2.62-A, the Schematic Diagram for the Model CA, it is seen that antenna coil L-106 is inductively coupled to L-107, the grid coil for VT-103, the r-f amplifier. L-107 is tuned by C-112. Grid bias for VT-103 comes from the 3-volt tap on the "C" battery. R-108 is a grid bias lead filter resistor, bypassed by C-113. C-114 bypasses the screen voltage lead to ground.

VT-104, the superregenerative detector, is a Type 19 twin-triode. One triode section is used for the interruption frequency oscillator, while the other section is the oscillating detector. L-108, tuned by C-115, is the detector coil. The output of VT-103, the r-f amplifier, is direct-coupled to L-108. Since L-108 carries d-c plate voltage, the wire bringing r-f output from VT-103 to L-108 also carries plate voltage to VT-103. C-116 and R-109 are respectively the grid condenser and grid leak for the oscillating detector. C-117, a bypass to ground, establishes the r-f ground point on L-108.

L-109 and L-110 are respectively the grid and plate coils for the interruption frequency oscillator. L-110 is tuned by C-119. C-118 and R-110 are the grid condenser and grid leak for the interruption frequency oscillator. Interruption frequency voltage is coupled into the oscillating detector circuit through capacitor C-120.

C-121, C-122, C-123, and C-124 are capacitors which bypass respectively the grid bias, filament, plate voltage, and r-f amplifier screen voltage leads.

The audio output of the detector is applied to the primary of T-102. Grid voltage for VT-102, the audio amplifier tube, is taken from a potentiometer across the secondary of T-102. Grid bias for VT-102 comes from the $4\frac{1}{2}$-volt "C" battery.

T-101, the output transformer, has two secondaries. One of these operates the speaker, while the other operates the handset receiver and the telephone line.

1.3 Power Supply Circuit

Power is supplied entirely from dry batteries. The $4\frac{1}{2}$-volt "C" battery mounts inside the Radiophone, while the "A" and "B" batteries are external to the Radiophone case. Connections to "A" and "B" batteries are made through the battery cable.

Two assemblies of batteries are recommended, the heavy-duty assembly for continuous standby service, and the medium-duty assembly for intermittent scheduled service. Types of batteries applicable to these 2 classifications of service are listed in 2.58 Batteries.

In the Model CA, the battery cable is provided with connections for 67, 135, and 180 volts for the "B" battery. In Models CB and CC the 67-volt connection is deleted. The battery cable has 2 A plus leads, one supplying the transmitter and the other the receiver. Since the present battery recommendations specify a single "A" battery for the Radiophone, these 2 leads should be connected to the plus terminal of the "A" battery. With this exception, battery cable connections are as shown in the "Instructions for Operating," furnished with the set. No battery box is supplied, since it is contemplated that the Radiophones will be used in lookout towers and ranger stations where shelf space is available.

Battery drains are as follows:

Battery voltage	3	135	180
Transmit drain	0.95 ampere	9.5 ma.	50 to 75 ma. (varies with modulation)
Receiver drain Models CB and CC	0.180 "	18.0 "	0 ma.
Receiver drain Model CA	0.440 "	18.0 "	0 ma.

1.4 Switching Circuits

The switching circuits may be divided into (a) on-off, (b) changeover, (c) operate-standy, and (d) meter.

The on-off switch SW-1 completes receiver and transmitter "A" battery circuits. In Models CB and CC it also connects ground to one side of the screen voltage potentiometer R-105 so that this potentiometer will not bleed the "B" battery when the Radiophone is turned off.

The changeover switch SW-2 selects Transmit, Receive, Duplex, or Telephone Line operation. In "TRANSMIT," "DUPLEX," and "TEL. LINE" positions, the lower portion of wafer #4 connects + 135 volts to speech amplifier VT-4, while the top portion of wafer #4 connects +180 volts to the remainder of the transmitting tubes. In "RECEIVE," "DUPLEX," and "TEL. LINE" positions, the lower portion of wafer #3 connects + 135 volts to the receiver tubes. In "TRANSMIT," "RECEIVE," and "DUPLEX" positions, wafer #2 connects the headphone winding of the receiver output transformer to the handset receiver, through the hook-switch. In "TEL. LINE" position, wafer #2 connects this winding to the telephone line. In "TRANSMIT," "RECEIVE," and "DUPLEX" positions, the microphone is connected in series with the "A" battery and the primary of the microphone transformer, through the hook switch, by wafer #1. In "TEL. LINE" position, wafer #1 connects the primary of the microphone transformer to the telephone line.

The hook switch, SW-3, connects 3-volt battery to transmitter filaments and microphone when the handset is off the hook. The upper portion of wafer #3 of SW-2 performs the same function when SW2 is in "TEL. LINE" position, so that the transmitter will operate with the handset on the hook when the "TEL. LINE" connection is used. Other contacts in the hook switch connect the handset receiver or the speaker to the audio output, according as the hook is up or down.

SW-5, a toggle switch at the rear of the panel meter, connects the meter to read final grid current, when thrown to the transmitter side. When thrown the other way, SW-5 connects meter terminals to SW-4, by means of which transmitter filament, receiver filament, and plate voltages, and also final plate current, are made to indicate on the panel meter.

1.5 Other Features

Two half-wave doublet antennas are supplied with the Type T Radiophone. One is cut to length corresponding to transmitter frequency, while the other is cut to length corresponding to the other frequency assigned to the forest. Each antenna has a rubber covered transmission line.

2.0 Adjustment and Repair, General

The following tools and equipment are needed for adjusting and repairing the Type T Radiophone:

(1) Usual complement of hand and bench tools.

(2) High-resistance d-c voltmeter - 1000 or more ohms per volt. Scales, 0-10, 0-50, 0-250 volts.

(3) D-c milliammeter, ranges 0-10, 0-50 ma.

(4) Ohmmeter.

Note: Above 3 items may be obtained in a single combination instrument.

(5) Heterodyne frequency meter, range 30 to 40 Mc.

(6) Tube checker.

If the Radiophone does not operate properly, the following procedure should be used in locating the trouble:

(1) Check all battery voltages. This should be done with the transmitter operating.

(2) Check tubes. If no tube checker is at hand, the tubes may be tried in a Type T Radiophone known to be in working order.

(3) Work the tubes in and out of their sockets to brighten the contacts.

(4) Inspect all switches. See that contacts are clean and making firm connection.

(5) Measure transformer resistances, and see that they are approximately the same as marked on Fig. 2.63, the Photodiagram.

(6) Inspect the Radiophone for loose, broken, or unsoldered connections. See that no parts are damaged or removed from their original locations in the Radiophone.

2.1 Transmitter Data

If transmitter fails to operate, search for trouble as outlined in Section 2.0. Check the wiring with Fig. 2.62, the Schematic Diagram. If this does not clear the trouble, it is likely that the transmitter needs retuning. This task should be undertaken only if actually necessary, and by a competent technician.

(1) Remove Radiophone from case. Disconnect plate voltage from final amplifier by disconnecting wire from TS-4 to secondary of modulation transformer.

(2) Connect batteries to battery cable. Turn SW-1 on, and remove handset from SW-3. Turn SW-2 to "TRANSMIT." Adjust transmitter filament voltage to 2.2 volts.

(3) Couple heterodyne frequency meter to L-1. This can be done by connecting a wire to the input of the frequency meter, and leading the free end of the wire to the vicinity of L-1. Vary C-1 until oscillator frequency is one-half of desired transmitter frequency. If the frequency meter range does not extend down to one-half the desired transmitter frequency, the second harmonic of the oscillator can be measured by the frequency meter.

(4) With plate voltage still disconnected, throw SW-5 toward transmitter, so that panel meter reads final grid current. Tune C-5 and C-11 for maximum final grid current. In general, these adjustments will affect the adjustment made in paragraph (3) so it will be necessary to go back and repeat (3), then repeat (4).

(5) With plate voltage still disconnected, neutralize. This is done by varying C-12 and C-13 until tuning C-14 through final plate circuit resonance causes no dip, or the least dip in final grid current. This condition will normally be met when C-12 and C-13 have approximately equal capacitance. This constitutes the rough neutralizing adjustment.

(6) Reconnect plate voltage to final amplifier by inserting 0-50 ma milliammeter between terminal on TS-4 and secondary of modulation transformer. This meter will read final plate current. Tune C-14 through final plate circuit resonance, noting whether maximum final grid current occurs at the same setting of C-14 as dip in final plate current. If not, neutralizing capacitors C-12 and C-13 must be readjusted until this condition is met. Adjustments in C-12 and C-13 should be made in very slight amounts. If C-12 and C-13 are varied in large amounts, the adjustment attained in paragraph (5) will be lost, and it will be necessary to repeat the adjustment made in (5).

While making the above adjustment, do not permit final plate current to exceed 25 milliamperes for longer than a few seconds.

(7) Measure transmitter frequency. If final amplifier adjustments have caused oscillator frequency to change, it will be necessary to repeat the procedure, possibly omitting step (5).

(8) Throw SW-5 toward receiver, and reconnect final plate voltage. Replace Radiophone in cabinet. Connect antenna, and turn SW-1 on. See that filament voltage is still 2.2 volts, then throw SW-4 to "TRANS. TUNE." Vary C-14 for minimum current in meter. This minimum current should be about 22 ma (i.e., 2.2 on meter scale). If reading differs from the above, adjust coupling between L-8 and L-9 until minimum plate current is 22 ma.

2.2 Receiver Data

If the receiver fails to operate, check as outlined in Section 2.0. Check the wiring with Fig. 2.62 for Models CB and CC, or Fig. 2.62-A for Model CA. The receiver is of simple design, and will operate if all connections are correct, and if all values are as shown in the Parts List.

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Oscillator tuning	50 mmf. variable	Hammarlund	APC-50
C2	" plate bypass	.001 mfd. mica	Aerovox	1460
C3	" grid	.001 " "	(Aerovox (Solar	1465) MT)
C4	Doubler coupling	20 mmf. " padder	Solar	TPS-A
C5	" plate tuning	25 mmf. variable	Hammarlund	APC-25
C6	" " bypass	.001 mfd. mica	(Aerovox (Solar	1465) MT)
C7	Filament bypass	.001 " "	Aerovox	1460
C8	Oscillator-doubler plate supply bypass	.001 " "	"	1460
C9	Final grid bypass	.0005 " "	"	1460
C10	Final grid bypass	.001 " "	(Aerovox (Solar	1465) MT)
C11	Final grid tuning	25 mmf. variable	Hammarlund	APC-25
C12	Final neutralizing	variable	"	Special APC-25 reduced to 4 plates
C13	" "	"	"	"
C14	Final plate tuning	31-31-mmf.	"	MCD-35-MX
C15	Audio plate bypass	0.5 mfd. 400 V	Aerovox	460

Capacitors C-101 to C-111 incl. in Models CB and CC only

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C101	Receiver tuning	15 mmf. variable	Hammarlund	HF-15
C102	Grid	50 mmf. mica	(Aerovox (Solar	1468) MO-1410)
C103	Screen bypass	.01 mf. 400-V paper	Solar	S-0219
C104	Interruption frequency oscillator grid	.00025 mf. mica	(Aerovox (Solar	1468) MO-1419)
C105	Interruption frequency oscillator tuning	.001 mf. mica	(Aerovox (Solar	1465) MT)
C106	Interruption frequency plate bypass	.0005 mf. mica	(Aerovox (Solar	1468) MO)
C107	Detector plate filter	.001 mf. mica	(Aerovox (Solar	1467) MW-1227)
C108	" " "	.00025 mf. mica	(Aerovox (Solar	1465) MT-1319)
C109	" " "	.001 mf. mica	Aerovox	1460)
C110	Audio blocking	.01 mf. 600-V	(Cornell-Dubilier (Solar	DT-6S1) S-0221)
C111	Audio plate bypass	.25 mf. 400-V	Aerovox	460

Capacitors C-112 to C-126 incl. in Model CA only.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C112	R-f grid tuning	20 mmf. variable	Hammarlund	MC-20-S
C113	R-f grid bypass	.001 mf. mica	(Aerovox (Solar	1467) MW-1227)
C114	Screen bypass	.002 mf. mica	(Aerovox (Solar	1467) MW-1233)
C115	Detector tuning	20 mmf. variable	Hammarlund	MC-20-S
C116	Detector grid	.0001 mf. mica	(Aerovox (Solar	1468) MO-1416)

Capacitors C-112 to C-126 incl. in Model CA only. (Cont.)

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C117	Detector bypass	.0001 mf. mica	(Aerovox (Solar	1467) MW-1216)
C118	Interruption frequency oscillator grid	.002 mf. mica	(Aerovox (Solar	1467) MW-1233)
C119	Interruption frequency oscillator tuning	.002 mf. mica	(Aerovox (Solar	1467) MW-1233)
C120	Interruption frequency oscillator coupling	.004 mf. mica	(Aerovox (Solar	1467) MW-1237)
C121	R-f amplifier grid return bypass	.001 mf. mica	Aerovox	1460
C122	Filament bypass	.001 mf. mica	Aerovox	1460
C123	Plate bypass	.001 mf. mica	Aerovox	1460
C124	R-f amplifier screen bypass	.001 mf. mica	Aerovox	1460
C125	Plate bypass	.5 mf. 400-V	Cornell-Dubilier	DA-4050
C126	Interruption frequency filter	.0005 mf. mica	Aerovox	1460

2.52 Inductors

SYMBOL	COMPONENT	DESCRIPTION
L1	Oscillator	13 turns #20 AWG enamel wire, tapped at 4-3/4 turn from top winding, 1" dia. x 7/8" long, on National Type XR-2 form.
L3	Doubler plate	6 turns #20 AWG enamel wire, winding 1" dia. x ½" long, on National Type XR-2 form.
L5	Doubler link coupling	1 turn #20 hook-up wire, looped over form of L3.
L6	Final link coupling	1 turn #20 hook-up wire, looped over form of L7.
L7	Final grid	7 turns #20 AWG enamel wire tapped at 3½ turns, winding 1" dia. x 5/8" long, on National Type XR-2 form.

2.52 Inductors (Cont.)

SYMBOL	COMPONENT	DESCRIPTION
L8	Final plate	2 coils, each 5 turns #16 AWG enamel, self-supporting, 3/4" inside dia. x 9/16" long, separated 11/32".
L9	Antenna coupling	2 turns #16 AWG enamel wire, self-supporting 3/4" inside dia. x 3/16" long, couples between halves of L8.

Inductors L-101 to L-105 incl. in Models CB and CC only.

L101	Receiver antenna coupling	2 turns #20 hookup wire 1" dia.	
L102	Receiver grid	7 turns #22 AWG enamel wire, close wound on National XR-3 form (9/16" dia. x 3/4" long).	
L103	Interruption frequency oscillator grid)	Bud	452
L104	Interruption frequency oscillator plate)		
L105	Audio choke	Thordarson	5298

Inductors L-106 to L-110 incl. only in Model CA

L106	Antenna coil	1 turn #20 hook-up wire, 3/4" dia., self-supporting, placed between turns of L107.	
L107	R-f grid coil	9 turns #14 bare tinned wire, self-supporting, wound on 3/4" form, 7/8" long.	
L108	Detector coil	9 turns #14 bare tinned wire, self-supporting, wound on 3/4" form, 1-1/8" long.	
(L109 (L110	Interruption frequency Oscillator coil	National	Type OSR

RFC-1	$2\frac{1}{2}$ m.h. 125 ma.	National	Type	R-100
RFC-2	" "	"	"	"
RFC-101	5.7 m.h. 750 "	Bud	"	925
RFC-102	250 m.h. 60 "	Hammarlund	"	RFC-250

Radio Hdbk.

2.53 Resistors

SYMBOL	COMPONENT	RATING		MANUFACTURER	TYPE
R1	Oscillator grid leak	50,000 ohms	1 watt	IRC	BT1
R2	Doubler grid leak	25,000 "	1 "	"	BT1
R3	Final grid filter	2,000 "	1 "	"	BT1
R4	Transmitter rheostat	3 "	variable	Mallory	M-3-R
R5	Audio voltage divider	150,000 "	$\frac{1}{2}$ watt	IRC	BT$\frac{1}{2}$
R6	" " "	75,000 "	$\frac{1}{2}$ "	"	BT$\frac{1}{2}$
R7	Meter shunt for final plate current	1 ohm	1 "	"	BT1
R8	Meter multiplier for 250 v. scale	50,000 ohms	1 "	"	BT1
R9	Meter multiplier for 5 v. scale	1,000 "	10 "	Ohmite	Brown Devil
R10	Meter shunt for final grid current	10 "		Special	
R11	Oscillator plate filter	3,000 "	1 "	IRC	BT1
R12	Meter series resistor - of such value as to make total meter resistance 10 ohms				Special

Resistors R-101 to R-107 incl. in Models CB and CC only.

SYMBOL	COMPONENT	RATING		MANUFACTURER	TYPE
R101	Grid leak	4 meg.	$\frac{1}{2}$ watt	IRC	BT$\frac{1}{2}$
R102	Interruption frequency grid leak	0.1 "	$\frac{1}{2}$ "	"	BT$\frac{1}{2}$
R103	Anode grid filter	75,000 ohms	$\frac{1}{2}$ "	"	BT$\frac{1}{2}$
R104	Receiver rheostat	15 "	variable	Mallory	M-15-R
R105	Screen potentiometer detector regeneration control	100,000 "	potentiometer	Centralab Mallory	72-122 Y-100MP

Resistors R-101 to R-107 incl. in Models CB and CC only. (Cont.)

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R106	Receiver volume control	200 ohms wire wound potentiometer	Mallory	X
R107	Receiver audio input control	250,000 ohms potentiometer tapered.	"	M

Resistors R-108 to R-110 incl. in Model CA only.

R108	R-f amplifier grid filter	30,000 ohms $\frac{1}{2}$ watt	IRC	BT$\frac{1}{2}$
R109	Detector grid leak	2 meg. $\frac{1}{2}$ "	"	BT$\frac{1}{2}$
R110	Interruption frequency oscillator grid leak	10,000 ohms $\frac{1}{2}$ "	"	BT$\frac{1}{2}$

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT1	Oscillator	Sylvania	31
VT2	Doubler	"	49
VT3	Final amplifier	"	19
VT4	Speech amplifier	"	1F4
VT5	Modulator	"	19
VT101	Detector	"	1D7G (only in Models CB and CC)
VT102	Audio amplifier	"	1F4
VT103	R-f amplifier	"	34 (only in Model CA)
VT104	Detector	"	19 (only in Model CA)

2.55 Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T1	Microphone	Phelps-Dodge	Inca 4702
T2	Driver	" "	" 2427
T3	Modulation	" "	" 02927
T101	Audio output	" "	" 4701
T102	Audio input	" "	" 4346 (only in Model CA)

2.56 Switches

SW1	On-off	3PST	Mallory	733
SW2	Transmit-receiver duplex-tel. line		"	1345L
SW3	Hook switch	SPST & SPDT		
SW4	Meter switch		Mallory	1315L
SW5	Meter switch	DPDT	H & H	Small toggle, with short nickel pl.shank

2.57 Terminal Strips

TS101	Det. output to audio input	In Model CB only.
TS102	Receiver audio output	In Model CB only.
TS103	Det. output to audio input	In Model CA only.
TS1	Final ampl. supply	
TS2	Oscillator-doubler supply	
TS3	Handset terminal	
TS4	Modulator - transmitter	
TS5	Telephone line	
TS6	Batteries	

2.58 Batteries

QUANTITY	USE	MANUFACTURER	TYPE
A. Heavy-Duty (Standby Service)			
1	"A" Battery	Eveready Burgess	X-125 20-F-2
4	"B" Batteries	Burgess General Eveready	21308 V-30-FL 386
1	"C" Battery	General	H-3-BF
B. Light-Duty (Intermittent Scheduled Service)			
4	"A" Batteries	General Eveready	#6 #7111 or #6 Ignitor
4	"B" Batteries	General Eveready Burgess	V-30-B 762-S or 762 5308
1	"C" Battery	General	H-3-BF

2.59 Miscellaneous

QUANTITY	COMPONENT	MANUFACTURER	TYPE
1	Speaker, 3" magnetic	Premier	
1	Headset	Trimm	USFS 100
1	Plug, headset cord	Mallory	75
1	Handset	Kellogg	41C
1	Cord, handset	Kellogg	F-705
1	Milliammeter, 0-5 ma.	(Triplett (Westinghouse	221) MX)
2	Insulators, thru panel	Johnson	40
2	Insulators, thru panel	Johnson	44

2.59 Miscellaneous (Cont.)

QUANTITY	COMPONENT	MANUFACTURER	TYPE
1	Socket, 4-prong ceramic	National	
1	Socket, 5-prong ceramic	National	
1	Socket, 6-prong ceramic	National	
1	Socket, octal ceramic	National	(only in Models CB and CC)
2	Sockets, 5-prong bakelite wafer	Cinch	Y-17
1	Socket, 6-prong bakelite wafer	Cinch	Z-17
1	Coupling, shaft	ARHCo	50-50C (only in Models CB and CC)
1	Dial	National	BM-1
6	Knobs	Mallory	366
1	Cable, battery, 5 conductor color coded; 2 #18 flex. BRC wires, 3 #20 flex. BRC wires		
1	Clip, grid	Bud	107
1	Strip, terminal 4-terminal, marked	ARHCo	1508
3	Tie points, 8 lugs		
3	Tie points, 7 lugs		
3	Tie points, 6 lugs		
5	Tie points, 3 lugs		
4	Grommets, 3/8" rubber	ARHCo	---
4	Grommets, $\frac{1}{4}$" rubber	ARHCo	---

2.59 Miscellaneous (Cont.)

All of the following components are only in Model CA.

SYMBOL	COMPONENT	MANUFACTURER	TYPE
2	Couplings, Shaft	National	TX-10
1	Knob	Mallory	366
1	Socket, 4-prong ceramic	National	
1	Socket, 6-prong ceramic	National	
2	Butt-ins	CPI	

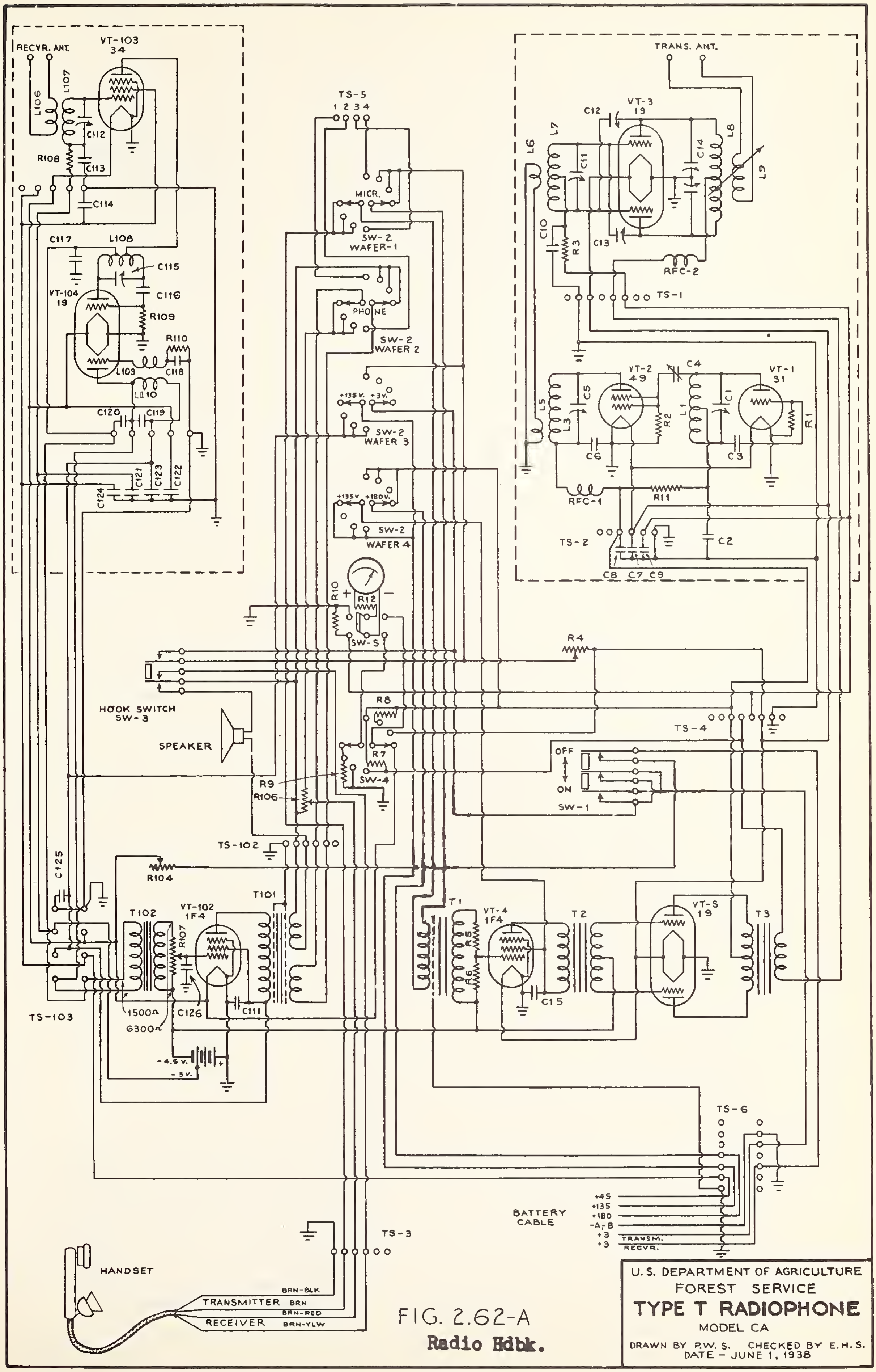

FIG. 2.62-A

Radio Hdbk.

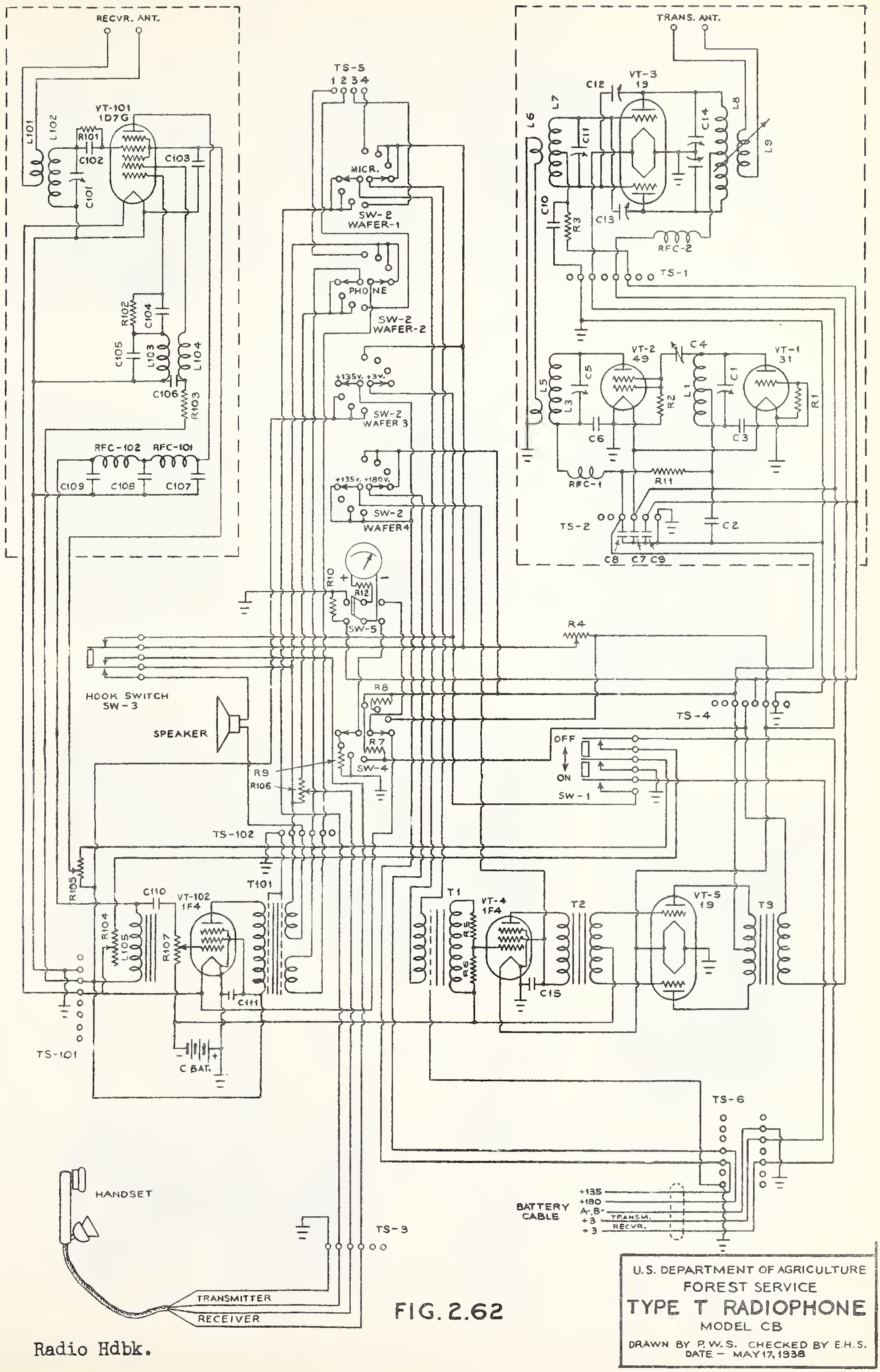
RECVR. ANT.
TRANS. ANT.
VT-101 1D7G
VT-102 1F4
VT-3 19
VT-2 49
VT-1 31
VT-4 1F4
VT-5 19
TS-1
TS-2
TS-3
TS-4
TS-5 1 2 3 4
TS-6
TS-101
TS-102
MICR.
SW-2 WAFER-1
PHONE
SW-2 WAFER-2
+135V. +3V.
SW-2 WAFER 3
+135V. +180V.
SW-2 WAFER4
SW-5
HOOK SWITCH SW-3
SPEAKER
OFF
ON
SW-1
SW-4
C BAT.
HANDSET
TRANSMITTER
RECEIVER
BATTERY CABLE
+135
+180
A-,B-
+3 TRANSM.
+3 RECVR.
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE T RADIOPHONE
MODEL CB
DRAWN BY P.W.S. CHECKED BY E.H.S.
DATE - MAY 17, 1938

FIG. 2.62

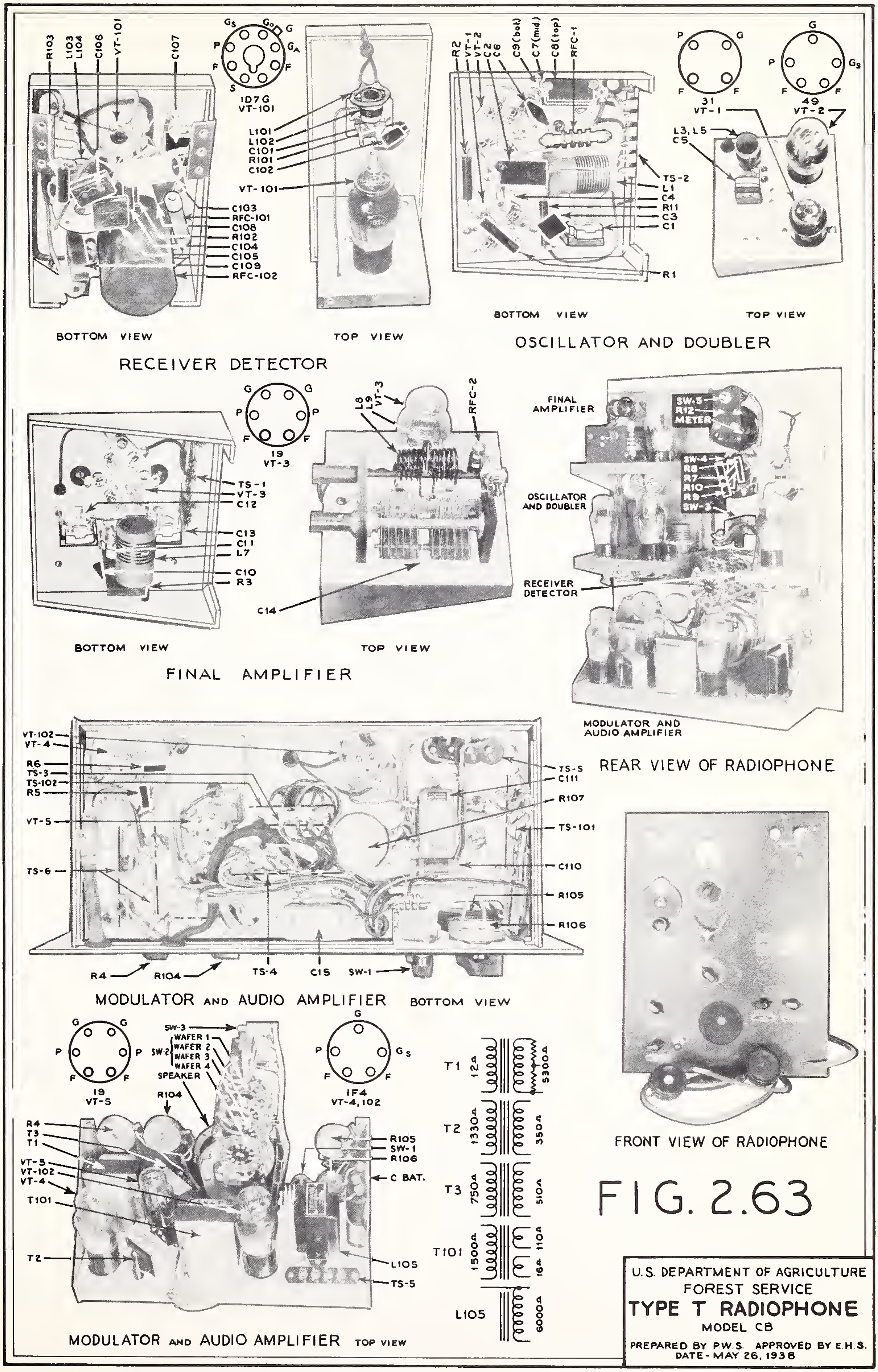

FIG. 2.63

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE T RADIOPHONE
MODEL CB
PREPARED BY P.W.S. APPROVED BY E.H.S.
DATE - MAY 26, 1938

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0.0 GENERAL DESCRIPTION

0.01 Capabilities of Radiophone

1. The Type T Model D Radiophone operates in the frequency range 32 to 39 Mc, and communicates with USFS types A, S, SV, T, and U Radiophones. Voice communication only is provided, and operation is "push-to-talk", as in the Type M. The transmitter is crystal controlled, and has a power output of 2 watts. The receiver is a sensitive superheterodyne, and is sufficiently broad to receive modulated oscillators, such as the Type S. The handset contains the microphone, telephone receiver, and "push-to-talk" switch. No loudspeaker is supplied.

2. A silent standby call buzzer is provided. This device operates when a signal is received, thereby avoiding a noisy loudspeaker in constant operation when unscheduled calls are expected. An extension alarm can be added, permitting operation of an extension bell in another room or building. See paragraphs 50, 51 and 52.

0.02 Factors Affecting Planned Use

3. The introduction of the Type T Model D is a major move pursuant to the aim of eventually having all radio equipment frequency stabilized. Among advantages offered by frequency stabilization are the following:

(a) Single-frequency forest networks are established and maintained with greater ease and reliability. The possibility of loss of contact caused by transmitter frequency drift is lessened many times.

(b) Stabilized transmitters make possible the use of selective receivers which are capable of discriminating against interfering signals.

(c) Frequency stabilized equipment conforms with new regulations made to permit increased utilization of radio facilities by all services.

4. The principal technical differences between the Type T Model D and its predecessors are listed below in Table 1:

TABLE 1

Technical Differences between Model D and Previous Models of Type T Radiophone

TYPE T, PREVIOUS MODELS	TYPE T, MODEL D
Receiver	**Receiver**
(a) Super-regenerative Circuit	(a) Superheterodyne Circuit
(b) 2-volt Tubes	(b) 1.4-volt Tubes
(c) Loudspeaker Standby	(c) Silent Standby (Call Buzzer)
Transmitter	**Transmitter**
(a) Master Oscillator	(a) Crystal-controlled Oscillator
General	**General**
(a) High Vertical Cabinet	(a) Low Flat Cabinet
(b) Panel Control for Transmit-Receive	(b) "Push-to-Talk" Switch on Handset
(c) Unit Construction Assembly	(c) Single Welded-Steel Chassis

5. Item (a) under Receiver in Table 1 is the most important difference between previous models and the Model D. The super-regenerative receiver is extremely broad in tuning. This feature results in certain advantages as well as disadvantages. With the broader tuning of the older receivers, it is possible to stand by over long periods without re-adjusting the tuning dial. In some instances it is also possible, with a moderate degree of reliability, to set the frequency of a Type S Radiophone by adjusting the tuning knob to a point marked on the scale and call a Type T receiver of a previous model. Slight errors in setting the Type S to exact frequency are compensated by the broad tuning of the super-regenerative receiver.

6. With increasing use of frequencies between 32 and 39 Mc, this same broad tuning characteristic is becoming more objectionable, on account of its inability to discriminate against interference on adjacent channels. The super-regenerative receiver is inherently noisy, and continuous stand-by operation is undesirable where noise from the loudspeaker may distract from other work.

7. The Type T Model D receiver employs a superheterodyne circuit having adequate broadness to receive modulated-oscillator transmitters, such as Types S and SV. However, it has eliminated the possibility of unattended remote-control installations which must receive tunable transmitters, such as Types S and SV. Such remote-control installations have been used infrequently, and no note need be made of this point unless the establishment of a Type T is contemplated at a remote location which will not be attended by an operator. In such installations, however, the Type T Model D is entirely satisfactory for receiving signals from crystal-controlled transmitters, such as Type A, Type U, or Type T Model D.

8. It may be worth re-stating that the Model D does receive Types S and SV Radiophones. However on account of the inaccuracy of frequency setting on Types S and SV transmitters, it is necessary to tune the Model D receiver to the frequency of the Type S or SV transmitter. Procedure for calling the Type T Model D with Type S or SV is described in <u>Instructions for Operating Type T Model D.</u>

9. Another consideration affecting the use of a Type T Model D on a network containing older models of the Type T is the matter of frequency drift caused by temperature change. In practically all receivers and transmitters, other than those which are both crystal and temperature controlled, a temperature change causes a frequency change. A given temperature change will cause a far greater frequency change in an older model of the Type T transmitter than in the crystal-controlled Model D. In the older models this frequency drift was compensated by the broad tuning characteristic of the receiver. However if it is attempted to make a Model D receiver stand by over long periods for an older transmitter, temperature change may cause the transmitter frequency to drift away from the setting of the more selective Model D receiver. Thus a call made several hours after the initial contact may not be completed. This difficulty can be overcome by arranging hourly contacts, and instructing operators to retune their receivers during each contact.

10. If both stations have Model D sets, however, the frequency drift would very rarely be sufficient to prevent completing the call, It would still be worthwhile to retune receivers for best reception.

11. Above considerations are discussed in detail because they may affect placement and planned use of the equipment.

12. The availability of a new series of 1.4-volt tubes has made possible an extremely worthwhile reduction in receiver battery consumption. Greatly increased battery life results.

13. Advantages of the silent standby call buzzer have been discussed. This device causes the buzzer to operate upon the cessation of a carrier of 10 microvolts or more. This 10-microvolt carrier is adequate to

produce a good voice signal, so there is good agreement between the sensitivity of the calling device and the minimum usable signal for voice reproduction.

14. The Type T Model D differs from older models in that it is more rugged and reliable, and its receiver is more selective and sentitive. Transmitter is adjusted with greater ease, and is frequency-stabilized. The relatively sharper tuning of the receiver does not mean that operation of the equipment has become more critical; however this feature must be kept in mind when planning the use of new equipment, as it may affect the distribution with relation to existing non-stabilized transmitters.

0.1 ELECTRICAL SPECIFICATIONS

Frequency Range	32 to 39 Mc
Frequency Control	Crystal
Power Output	2 Watts
Distance Range	Optical Path
Type Operation	Simplex Voice (Push-to-Talk)
Power Supply	Dry Batteries
Input	Handset Microphone
Output	Handset Receiver
Tube Complement	1 Type 1H4G Oscillator
	1 Type 1H4G Doubler
	1 Type 1J6G Final Amplifier
	1 Type 1F5G Speech Amplifier
	1 Type 1J6G Modulator
	1 Type 1A7G Converter
	3 Type 1N5G I-f Amplifiers
	1 Type 1H5G Detector and A-f Amplifier
	1 Type 1N5G Automatic Alarm Tube
	1 Type 1F1 Ballast Tube
Antenna	USFS Type J, Copper-Wire Model

0.2 PHYSICAL SPECIFICATIONS

Radiophone Dimensions	17-1/4" wide x 7" high x 7" deep
Radiophone Dimensions, packed in shipping case, complete with antenna, handset, and cables, but without batteries.	18-3/4" wide x 11" high x 9-3/4" deep
Radiophone Weight, packed in shipping case, complete with antenna, handset, and cables, but without batteries.	30 pounds

Weight of Batteries, Heavy-duty for Standby Service	86 pounds
Weight of Batteries, Medium-duty for Intermittent Service.	21 pounds

1.0 DETAILED DESCRIPTION

15. The receiver occupies the left-hand section of the chassis, while the transmitter is built in the right-hand section. Receiver is tuned with a vernier-type main tuning dial, and an antenna-trimmer knob directly above the main tuning dial. The remaining receiver knob is the volume control. A screw-driver adjustment for alarm-tube sentitivity is accessible through a panel hole beneath the main tuning dial. Normally this adjustment would be made during the installation, and need not be repeated until the Radiophone is moved to another location.

16. The meter and meter switch provide means for measurement of transmitter filament voltage, "B" battery voltage, final amplifier plate current, and for indication of received carrier strength.

17. Adjustment of transmitter loading and resonance is accomplished by means of screwdriver controls accessible through holes marked "R" and "L" in the panel. Transmitter filament voltage may be controlled by the "TRANS FIL" knob on the panel; or, by turning this knob all the way to the left, this voltage is controlled by a ballast tube.

18. The panel also contains sockets for battery and handset cables, the "ON-OFF" switch, and the 2 antenna terminals.

19. In addition to the "push-to-talk" switch, the handset contains a hook switch. This hook switch makes the call buzzer operative only when the handset is hung by its ring, thereby avoiding false operation of the alarm during conversations.

20. Shorting-type twin-tip jacks are provided on the rear of the chassis for measurement of oscillator plate current, doubler grid and plate currents, and final amplifier grid and plate currents. These jacks may also be used for opening plate voltage supplies during transmitter adjustment.

1.1 TRANSMITTER CIRCUIT

21. A Type 1H4G crystal oscillator excites a Type 1H4G doubler, which drives a Type 1J6G push-pull modulated amplifier. A Type 1F5G speech amplifier drives the Class B 1J6G modulator.

22. Referring to Fig. 2.62, the Schematic Diagram, crystal oscillator VT-1 operates at one half the transmitter frequency. L-1 and C-1 form the plate load circuit, and feedback is provided through

inductive coupling between L-1 and L-2. As the crystal is used in the oscillator, it is equivalent to a series resonant circuit. R-1 is the oscillator grid leak. J-1 and J-2 are shorting-type twin-tip jacks, which permit measurement of oscillator plate and doubler grid currents, respectively.

23. L-3 and C-4, resonated to the operating frequency of the transmitter, form the plate load tank circuit for doubler tube VT-2, L-4, the final amplifier grid coil, is tightly coupled to L-3, and drives the grids of VT-3 in push-pull. J-3 and J-4 are shorting-type twin-tip jacks which permit measurement of doubler plate and final-amplifier grid currents, respectively.

24. L-5 together with C-8 and C-9 form the plate tank circuit for the final amplifier, C-6 and C-7 are neutralizing capacitors. RFC-1 isolates the center tap of L-5 from r-f ground, Plate voltage is supplied to VT-3 in series with the secondary of modulation transformer T-3 and RFC-1. The a-f voltage produced in the secondary of T-3 by the modulator is in series with the d-c plate voltage. This results in plate modulation of VT-3.

25. L-6, the antenna pick-up coil, is coupled between the 2 halves of L-5, Since the center of L-5 is near the ground potential, stray capacitive coupling between L-5 and L-6 is avoided. C-129 compensates the inductance of L-6 and the lead to the "ANT" post.

26. Referring to the audio-frequency section of the transmitter, the microphone is connected through the handset cable in series with current-limiting resistor R-15, the primary of microphone transformer T-1, and the "A" battery. Voltage from the secondary of T-1 is applied to the grid of speech amplifier VT-5. Blocking capacitor C-11 together with voltage-dividing resistors R-7 and R-8 constitute a circuit by means of which a portion of the amplified signal from the plate circuit of VT-5 is applied back to the grid of VT-5. The phase of the amplified a-f plate voltage is opposite to that of secondary voltage from T-1. Thus the net signal applied to the grid is less than the secondary voltage of T-1, and this arrangement is accordingly a form of "inverse feedback", or "degeneration". The result of this inverse feedback is a reduction in effective plate resistance of VT-5, which reduces distortion in the signal applied to the modulator grids. Also, the total gain is reduced, thereby preventing overmodulation in transmitter output.

27. Speech amplifier VT-5 drives the grids of modulator VT-4 in push-pull, through driver transformer T-2. Plate voltage is supplied to VT-3 in series with the secondary of modulation transformer T-3 and RFC-1. The a-f voltage produced in the secondary of T-3 by the modulator is in series with the d-c plate voltage. This results in plate modulation of VT-3.

28. Transmitter filament voltage is controlled either by ballast tube VT-201, or by rheostat R-11. Variations in ballast tubes are compensated by adjustment of ballast-tube-compensating resistor R-12. See paragraph 70. It is intended that the ballast tube provide voltage control

during all except the last portion of the useful battery life. When battery voltage has dropped so low that sufficient filament voltage cannot be obtained in series with the ballast tube, the rheostat is switched in by SW-201, operated from the rheostat shaft.

29. Bias voltage for doubler VT-2, speech amplifier VT-4, and modulator VT-5 is obtained by plate current drop through R-10.

1.2 RECEIVER CIRCUIT

30. The receiver contains a 1A7G converter, 3 stages of 4050-kc i-f amplification using 1N5G tubes, a 1H5G detector and audio amplifier, and a call-buzzer circuit utilizing a 1N5G tube,. The i-f band width is approximately 50 kc. This comparatively wide band permits reception of modulated oscillators, such as the Type S Radiophone, and also compensates for slight drift of crystal-controlled transmitters during standby receiver operation.

31. Receiver tubes have 1.4-volt, 50-ma filaments. Pairs of these filaments are connected in series across the 3-volt supply without series resistors. R-f chokes RFC-101 to RFC-104 inclusive isolate filament terminals from one another and from positive "A" battery. Capacitors C-105, C-106, C-110, C-114, C-117, and C-118 bypass filament terminals to ground.

1.21 SIGNAL CIRCUITS

32. Antenna coil L-101 induces signal currents into converter-grid coil L-102, which is resonated by tuning capacitor C-101 and "ANT TRIM" capacitor C-103. The h-f oscillator section of the converter employs a tuned anode circuit, in which L-104 is the tuned anode coil, and L-103 the oscillator-grid coil, C-102, the rear half of the ganged tuning capacitor, tunes L-104. C-127 and R-102 are respectively the oscillator-grid capacitor and grid leak.

33. I-f signal from the plate of converter VT-101 is amplified by the 3-stage i-f amplifier, consisting of tubes VT-102, VT-103, and VT-104, and 4050-kc i-f transformers T-101, T-102, T-103, and T-104. A-V-C bias is applied to grids of VT-102 and VT-103, but not to VT-104. Amplified i-f signal from the secondary of T-104 is detected by the diode of VT-105. C-121 bypasses i-f currents across diode-load resistor R-115.

1.22 BUZZER ALARM CIRCUITS

34. The circuit associated with VT-106, the call-buzzer alarm tube, is such that when no carrier is received, or when a steady carrier is received, Relay-101 is energized and its contacts are held open, thereby preventing operation of the buzzer. However, when a carrier is received and suddenly ceases, Relay-101 is de-energized for a period of about 5 seconds, thereby causing buzzer operation during this interval.

35. Referring to Fig. 2.62, the Schematic Diagram, it is seen that plate voltage is supplied to VT-106 in series with the winding of Relay-101, the plate load. C-126 is a relatively large capacitance between the grid of VT-106 and a tap on R-109, the screen dropping resistor for i-f amplifiers VT-102 and VT-103. R-119 is a high-resistance grid-leak resistor, returned to the positive side of the filament.

36. For purpose of explanation, assume the contact arm of potentiometer R-109 is set at the screen end; that is at the right-hand end of R-109 as shown in Fig. 2.62. With no received carrier, A-V-C voltage on VT-102 and VT-103 will be constant, and screen currents in these tubes will be constant. The d-c potential on the contact arm of R-109 will then be constant. Grid of VT-106 will be held at the potential of the positive side of the filament by the circuit through R-119, and C-126 will serve simply as a blocking capacitor. Under these conditions the grid voltage of VT-106 is such that plate current will flow, thereby energizing Relay-101 and holding its contacts open. The buzzer, which is connected in series with these contacts and the receiver "A" battery, thus is prevented from operating.

37. Assume that the circuit has been operating with no received carrier, as outlined in paragraph 36, and that a carrier is tuned in. A-V-C voltage will rise, causing a decrease in screen currents in VT-102 and VT-103, and therefore a decrease in current through R-109. The IR voltage drop across R-109 will be suddenly decreased, and the positive potential on the contact arm will be suddenly increased. The charge on capacitor C-126 will tend to be increased, due to higher applied voltage. The charging current can flow through the grid-filament conduction path of VT-106, because the direction of current conduction within the tube is correct for this flow to exist. When capacitor C-126 has acquired its increased charge, circuit operation becomes stabilized under the new conditions, provided carrier strength remains constant. During all of the foregoing the plate current of VT-106 has continued to flow, thus holding the buzzer circuit contacts open on Relay-101.

38. Assume now the carrier ceases. A-V-C voltage suddenly decreases, screen currents through VT-102 and VT-103 increase, and the IR voltage drop across R-109 increases. This lowers the positive potential at the contact arm. The charge on capacitor C-126 will tend to be decreased, due to the lower applied voltage. However the discharge current cannot flow through the grid-filament conduction path of VT-106, because the direction of current conduction within the tube is incorrect for this flow to exist. The partial discharging of C-126 due to the lower applied voltage must therefore take place over an interval of several seconds through the high resistance of R-119. Before this partial discharge has had time to occur, a negative voltage will be applied to the grid of VT-106. The magnitude of this voltage will be the difference between the charge on C-126 with carrier on, and the voltage applied to the contact arm of R-109 with carrier off. This negative grid voltage will decrease gradually as C-126 completes its partial discharge through R-119.

39. During the time the grid of VT-106 is sufficiently negative, plate current will be cut off. This cessation of plate current de-energizes Relay 101, thereby closing its contacts and operating the buzzer. Thus the operation of the buzzer is seen to depend upon the interruption of a carrier.

40. RFC-105, RFC-106, C-125, and R-123 are r-f filter components which prevent the establishment of r-f transients in the receiver circuits by the intermittent contacts of the buzzer. Such r-f transients would react through the A-V-C circuit to cause continuous operation of the buzzer, once it had been started.

41. SW-101 is a hook switch in the handset, and is open when the handset hangs by its ring. When the handset is removed from its ring, as during normal use of the Radiophone, SW-101 closes, thereby completing the circuit of Relay-101 winding from positive "B" battery to ground, through resistor R-122 and the handset cable, Thus when the Radiophone is in use Relay-101 is energized continuously, thereby preventing false operation of the call buzzer during normal communication, due to varying carrier level and short intervals during which carrier may be turned off. Obviously the handset must be left hanging by its ring during periods of receiver standby.

42. The adjustment on R-109 provides control of the sensitivity of the call-buzzer circuit; that is, control of the minimum carrier strength for which the buzzer will operate. There will be a few locations close to automobile traffic or other sources of disturbance where false operation of the call buzzer would be experienced if the alarm circuit was left fixed in its most sensitive adjustment. For such locations the contact arm on R-109 is set so that the call buzzer will not respond to prevailing disturbances. Under these conditions a somewhat stronger carrier will be required to operate the buzzer. This adjustment must be made only by authorized technicians, and must be set at the most sensitive position which will avoid false alarms. Obviously, if the adjustment reduced buzzer-circuit sensitivity too much, incoming calls would be lost.

1.3 POWER SUPPLY CIRCUIT

43. A 3-volt "A" battery and a 180-volt "B" battery are required. No "C" battery is used.

44. Two classifications of batteries are recommended, one for heavy-duty standby service, and one for medium-duty intermittent service. The heavy-duty batteries should render about 30 days service under conditions of standby receiver operation 18 hours per day, and intermittent infrequent transmitter operation. The medium-duty batteries should provide about 100 service hours of non-standby schedule operation.

45. Batteries recommended for each type of service are listed in the Parts List, 2.58, Batteries.

1.4 SWITCHING CIRCUITS

46. SW-202, the "ON-OFF" switch, breaks filament and plate supply for the entire Radiophone. SW-201, mounted on the transmitter rheostat shaft, selects either ballast tube or rheostat control for transmitter filament voltage.

47. SW-1, the push-to-talk switch on the handset, grounds the winding of Relay-1, thereby energizing the relay. In the energized, or transmit position, contacts of Relay-1 connect antenna to the transmitter antenna pick-up coil, and positive "A" battery to transmitter filaments and microphone. In the de-energized, or receive position, these contacts connect antenna to receiver, and positive "A" battery to receiver filaments and call-buzzer supply.

48. SW-301, the meter switch, permits use of the 0-5 milliameter for measurement of transmitter filament voltage, final-amplifier plate current, "B" battery voltage and receiver-carrier-strength indication. With SW-301 in "FIL VOLTS" position, the meter is connected in series with multiplier R-303 across transmitter filament leads. R-303 is of such value as to provide a 0-5 volt range. With SW-301 in "TRANS TUNE" position, the meter is connected in parallel with R-301, a shunt which provides a 50-ma full scale range. In this position plate current of final amplifier VT-3 is measured. With SW-301 in "RECV TUNE" position, the meter measures plate and screen currents of VT-102 and VT-103. Since these 2 i-f amplifiers have A-V-C bias applied to their grids, plate and screen currents will decrease with increasing carrier level, and the amount of this decrease is a measure of carrier level. R-124 completes the "B" battery supply circuit to plates and screens of VT-102 and VT-103 when the meter is switched away from "RECV TUNE". With SW-301 in "B VOLTS" position, the meter is connected in series with multiplier R-302 across the "B" battery leads. R-302 is of such value as to provide a 0-200 volt range on the meter.

1.5 OTHER FEATURES

1.51 Antenna

49. The antenna provided with the Radiophone is the USFS Type J, Copper Wire Model. The Galvanized Pipe Model of the Type J may be erected at installations which will be operated for several months. See Sec. C9.203 of this Handbook.

1.52 Extension Alarm Bell

50. It is possible to provide an extension bell which will operate in another room or building whenever the buzzer alarm operates. Relay-101,

being of the sensitive type, has limited contact ratings. Therefore, it is necessary to control the extension-bell circuit by means of another relay.

51. The winding of the external relay should be connected in parallel with the buzzer, as shown in Fig. 1. The terminal strip at the rear of the chassis may be used to bring these connections outside the cabinet. One of the 2 leads from the external-relay winding is grounded to the Radiophone chassis, while the other is connected to the junction between RFC-105 and the contact on Relay-101. This junction is terminal #2 on the relay socket. The external relay and extension-alarm-bell battery should be located close to the extension-alarm bell, so that leads in the local bell circuit will be kept short. A .001 mfd. capacitor (Aerovox Type 1467 or Solar Type MW-1227) is connected across external-relay contacts, and a .0005 mfd. capacitor (Aerovox Type 1465 or Solar Type MT-1322) is connected across bell terminals. Capacitor leads should be as short as possible. The foregoing precautions are necessary to prevent r-f noise originating in bell and relay contacts from re-entering the receiver and thereby causing continuous operation of the buzzer and bell. A switch should be provided by means of which the extension alarm may be disconnected.

52. Since current-carrying capacity of Relay-101 contacts is limited, winding of the external relay should have a fairly high resistance. A Guardian Type 15-25-A2 is recommended. This relay takes 120 ma at 3 volts, and has adequate contact rating to operate the bell circuit. A 6-volt doorbell such as the Edwards Type No. 743 together with four #6 dry cells will usually be satisfactory for the extension alarm, unless for some reason a very loud alarm is needed.

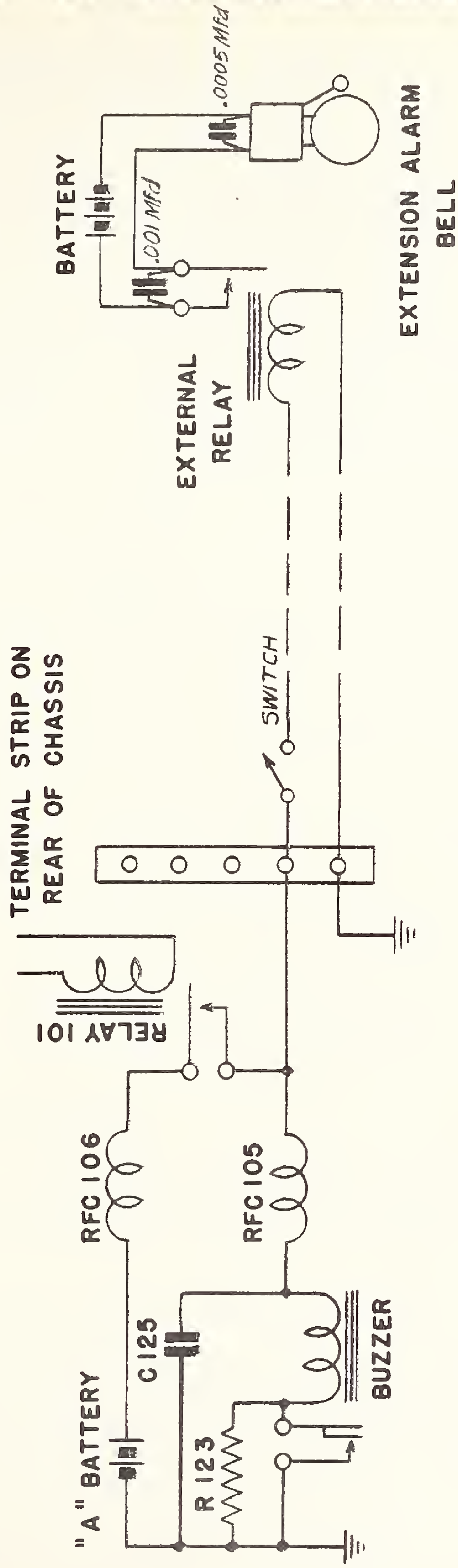


FIG. I CONNECTIONS FOR EXTENSION ALARM BELL

8-17-39

2.0 ADJUSTMENT AND REPAIR, GENERAL

2.01 Tools and Equipment Needed

53. The following tools and equipment are needed for adjusting and repairing the Type T Model D Radiophone:

(a) Usual assortment of hand and bench tools.

(b) High-resistance d-c voltmeter - 20,000 or more ohms per volt, such as Weston Type 772 or RCA "VoltOhmyst" Vacuum-Tube Voltmeter. Ranges needed, 0-2.5, 0-10, 0-50, 0-250 volts.

(c) D-c milliammeter,ranges 0-10, 0-50, 0-250 ma.

(d) Ohmmeter.

Note: Items (b), (c), and (d) may be obtained in a single combination instrument.

(e) D-c milliammeter, range 0-1 ma.

(f) D-c milliammeter, range 0-25 ma.

(g) Tube Checker.

(h) USFS Type A Test Set. (See Sec. 12.301)

(i) Signal Generator capable of operation on 4050 kc.

(j) USFS Type D Frequency-Modulated Oscillator (See Sec. 12.302).

(*) (k) Oscilloscope, cathode ray

(l) Fibre Neutralizing Wrench or Screwdriver.

2.02 Locating Trouble

54. If the Radiophone does not operate properly, trouble should be sought first at points where it is most likely to occur. Procedure of the following paragraphs 55 to 64 inclusive, should be followed in order.

55. Check all battery connections.

56. Check all battery voltages. This should be done with the transmitter operating and delivering power to an antenna or dummy antenna. A satisfactory dummy load consists of 2 Mazda 44 or Mazda 46 6-volt lamps connected in series.

57. Check battery cable. This may be done by measuring voltages on the terminal side of battery-cable socket S-2, with the battery plug inserted. Test for intermittent or loose connections on cable plug and for intermittent open circuits in the cable wires.

58. See that battery and handset cables are firmly plugged into their sockets and making good connection.

59. Check handset cable. Inspect cable for physical damage. Make continuity checks between ground pin (#4) on plug and each of the other pins, and compare results of this check with Table 2. For key to numeral designations of pins, see Fig. 2.62, the Schematic Diagram.

TABLE 2

Normal Resistances Between Pins on Handset Cable

Continuity between Pin #4 and	Ohmmeter Reading
Pin #1	2 Ohms when Push-to-Talk Switch Closed
Pin #2	30 ohms. Handset receiver should produce audible clicks when ohmmeter circuit is intermittently made and broken.
Pin #3	Between 30 and 500 Ohms, depending upon position of microphone.
Pin #5	2 Ohms when Hook Switch Released.

60. Inspect all switches and relays. See that contacts are clean and making firm connections.

61. Work the tubes in and out of their sockets to brighten the contacts.

62. Check tubes. If no tube checker is at hand, tubes may be tried in a Type T Model D Radiophone known to be in working order.

63. Inspect Radiophone for loose, broken, or unsoldered connections. See that no parts are damaged or moved from their original locations on the chassis.

64. Measure transformer resistances, and see that they are approximately the same as marked on Fig. 2.63, the Photodiagram.

2.1 TRANSMITTER DATA

2.11 Locating Trouble

65. If transmitter fails to operate, search for trouble as outlined in paragraphs 55 to 64, inclusive. If this fails to clear the trouble, check operating currents by use of pin jacks in rear of chassis. These measurements should be made with the transmitter operating into an antenna or dummy antenna. In the case of each pin jack, the plus milliammeter prod is inserted in the upper jack. Approximate values for the various circuits appear in Table 3. CAUTION: Do not permit one milliammeter prod to contact the chassis while the other prod is in contact with a pin jack. Such contact will result in "B"-battery voltage being applied across the milliammeter, and consequent damage to the meter. To be safe, always turn "ON-OFF" switch "OFF" while inserting or removing prods.

TABLE 3

Approximate Normal Currents Measured in Pin Jacks

Note: Currents tabulated are approximate, not exact.

JACK SYMBOL	JACK DESIGNATION	APPROXIMATE NORMAL CURRENT
J-1	OSC PLT	10 ma
J-2	DBLR GRD	0.5
J-3	DBLR PLT	10
J-4	AMP GRD	5
J-5	AMP PLT	22

66. An abnormal reading for one or more of the foregoing measurements may be due to a faulty component, a defective tube, or to the need for tuning the transmitter. Check the wiring with Fig. 2.62, the Schematic Diagram, and examine components for evidence of defects. Measure voltages on tube-socket terminals. An abnormal voltage will suggest the location of a defective component. If tube-socket voltages are normal, yet pin-jack currents are abnormal, it is likely that the transmitter needs retuning. This job should be undertaken only if actually necessary, and by a competent technician.

2.12 Preliminary Transmitter Tuning with Reduced Voltage

67. Remove one of the four 45-volt "B" batteries, so that net "B" voltage is 135 volts.

68. Work the crystal holder in and out of its socket a few times to brighten the contacts. Make sure the crystal holder is plugged in such manner that red paint on the spring clip lines up with that on the holder. If crystal holder is plugged in reversed, R-1 will be short-circuited and crystal oscillator VT-1 will operate without bias.

69. Disconnect plate voltage from doubler and final amplifier. This is done most conveniently by inserting pin tips into both holes of "DBLR PLT" and "AMP PLT" jacks J-3 and J-5. If no pin tips are at hand, the butt ends of wooden matches may be used.

70. Turn "TRANS FIL" knob all the way to the left (until a click is heard), so that ballast tube VT-201 is in the circuit, and turn meter switch SW-301 to "FIL VOLTS". Turn "ON-OFF" switch on, and press handset button. Note meter reading. If "A" batteries are new (terminal voltage under load between 2.9 and 3.1 volts), meter should read on the red line (2.15 volts). With such new "A" batteries, meter reading may be corrected if necessary to read on the red line by adjustment of ballast tube compensating control R-12. If "A" battery terminal voltage under load is less than 2.9 volts, do not attempt adjustment of R-12, but bring meter to red line by adjustment of "TRANS FIL" knob, R-11. Release handset button.

71. Plug a 0-25 (or 0-50) milliammeter into "OSC PLT" jack J-1, and a 0-1 milliammeter into "DBLR GRD" jack J-2. Turn oscillator plate-tuning capacitor C-1 to maximum capacitance and press handset button. Slowly decrease capacitance of C-1 until oscillator plate current, as indicated by meter in "OSC PLT" jack J-1, dips sharply. Doubler grid current, as indicated by meter in "DBLR GRD" jack J-2, will rise suddenly about the same time oscillator plate current dips. Continue to decrease capacitance of C-1 until doubler grid current is maximum. Do not turn C-1 part way back for fine adjustment. Repeat from maximum capacitance if you have turned too far. Release handset button, disconnect milliammeter from "OSC PLT" and "DBLR GRD" jacks J-1 and J-2, and extract pin plugs from "DBLR PLT" jack J-3. Leave pin plugs in "AMP PLT" jack J-5.

72. Plug a 0-10 milliammeter into "AMP GRD" jack J-4. With plate voltage still disconnected from final amplifier, press handset button. Tune doubler plate-tuning capacitor C-4 for maximum final-amplifier grid current, as indicated by meter in "AMP GRD" jack J-4. Release handset button.

73. The next step is a test for neutralization of the final amplifier. Unless final amplifier VT-3 has been changed, or the setting of neutralizing capacitors C-6 or C-7 has been disturbed, neutralization will probably be correct. The test described in this paragraph reveals only moderate or large departures from neutralization. Move antenna pick-up coil L-6 to minimum coupling with final-amplifier plate coil L-5. With plate voltage on final amplifier still disconnected, press handset button and tune final-amplifier resonating capacitor C-8 C-9 through resonance of the final amplifier tank circuit. If final-amplifier grid current dips markedly as C-8 C-9 tune through resonance, neutralization is in need of adjustment, and the procedure of paragraph 74 may be omitted. Release handset button.

74. The test described in this paragraph reveals small departures from neutralization. Remove pin plugs from "AMP PLT" jack J-5, and turn meter switch SW-301 to "TRANS TUNE". Watching both the panel meter and the final-amplifier grid-current meter, press handset button and tune final-amplifier resonating capacitor C-8 C-9 through resonance.

Do not permit final-amplifier plate current to exceed 30 ma except momentarily. If neutralization is correct, final-amplifier grid current will rise at the same time plate current dips through resonance. If the grid current rise is not co-incident with the plate current dip, neutralization is incorrect. Release handset button. Disconnect meter from "AMP GRD" jack J-4.

2.13 Completing Transmitter Tuning with Full Plate Voltage

75. Before proceeding to neutralize if tests of paragraphs 73 and 74 have shown such to be necessary, the oscillator and doubler should be retuned with full plate voltage. Replace the fourth 45-volt unit in the "B" battery, so that the net voltage is 180 volts. Disconnect plate voltage from final amplifier by inserting pin plugs in "AMP PLT" jack J-5.

76. Replace 0-25 (or 0-50) milliammeter in "OSC PLT" jack J-1, and 0-1 milliammeter in "DBLR GRD" jack J-2. Press handset button and make a very slight readjustment of oscillator plate-tuning capacitor C-1 for maximum doubler grid current, but such that oscillator plate current does not exceed 12 ma. Release and press handset button several times to make sure oscillator starts reliably. Oscillator plate current will normally be about 10 ma; if it is less than 9 ma, a new tube should be tried for crystal oscillator VT-1. Release handset button.

77. Remove the 0-25 (or 0-50) milliammeter from "OSC PLT" jack J-1, and plug it into "DBLR PLT" jack J-3. Plug a 0-10 milliammeter into "AMP GRD" jack J-4. Press handset button and retune doubler plate-tuning capacitor C-4 for maximum final-amplifier grid current and minimum doubler plate current. Doubler plate current should then be about 10 ma. If this current is less than 9 ma, or more than 12 ma, a new tube should be tried for doubler VT-2. If a new tube is inserted for VT-2, it will be necessary to repeat procedures of paragraphs 76 and 77. Release handset button, remove meters from "DBLR GRD", "DBLR PLT", and "AMP GRD" jacks, J-2, J-3, and J-4.

78. Paragraphs 78, 79 and 80 describe methods of neutralizing the final amplifier stage. This should be undertaken only if the necessity is indicated by tests outlined in paragraphs 73, and 74. Set neutralizing capacitors C-6 and C-7 visually such that their capacitances are approximately equal, and about two-thirds of maximum capacitance. Plug into the USFS Type A Test Set the rectifier-wavemeter coil which is correct for your assigned frequency. Couple this coil loosely to doubler plate coil L-3, and turn the Test Set switches such that it operates as a rectifier wavemeter. With plate voltage to final amplifier still disconnected, press handset button, and tune the Test Set dial for maximum deflection of the Test Set meter; that is, resonate the Test Set with the operating frequency of the transmitter. If the meter goes off scale, loosen the coupling to doubler plate coil L-3. Remove Test Set, and without disturbing setting of its tuning dial,

couple its coil to final-amplifier plate coil L-5. Adjust final-amplifier resonating capacitor C-8 C-9 for maximum deflection of Test Set meter. Maintaining the coupling between Test Set coil and L-5 constant, adjust only neutralizing capacitor C-6 for minimum deflection of Test Set meter. A fibre socket wrench or screwdriver should be used for this adjustment. Note carefully the positions of neutralizing capacitors C-6 and C-7. Move each rotor half way to the position of the other; that is, readjust C-6 and C-7 such that their capacitances are equal, and approximately the average of their former positions. Repeat this procedure until Test Set meter shows minimum deflection, and C-6 and C-7 have approximately equal capacitance settings. Release handset button and turn off Test Set. Check neutralization by the method of paragraph 74.

79. If no USFS Type A Test Set is available, the following method of neutralization may be used. Plug a 0-10 milliammeter in "AMP GRD" jack J-4, and disconnect plate voltage from the final amplifier. Set neutralizing capacitors C-6 and C-7 visually such that their capacitances are equal, and about two-thirds of maximum capacitance. Press handset button. Vary final-amplifier resonating capacitor C-8 C-9, noting the amount of the dip in final-amplifier grid current which occurs when C-8 C-9 pass through resonance. Re-adjust only C-6 until a position is found for which there is the least dip in final-amplifier grid current as C-8 C-9 tune through resonance, Note carefully the positions of C-6 and C-7. Move each rotor half way toward the position of the other; that is, readjust C-6 and C-7 such that their capacitances are equal, and approximately the average of their former positions. Repeat this procedure until C-6 and C-7 have equal capacitance settings, such that there is the least dip in final-amplifier grid current as C-8 C-9 tune through resonance. Release handset button. Check neutralization adjustment by the method of paragraph 74. If this check reveals a departure from correct neutralization, C-6 and C-7 may be varied by very minute amounts until the paragraph 74 check shows the neutralization to be correct, and visual inspection shows C-6 and C-7 to have equal capacitances. It is necessary that the successive variations in C-6 and C-7 be very slight, or the adjustment attained previously will be lost, and the procedure of the first part of this paragraph will have to be repeated. In making these small adjustments with the check of paragraph 74, if a metal-tipped fibre screwdriver is used to vary C-6 and C-7, extreme care must be taken to avoid accidental contact between rotor of C-6 or C-7 and chassis, as this will apply "B" battery voltage across R-301, the meter shunt. Obviously, meter switch SW-301 must be turned away from "TRANS TUNE" while adjusting C-6 and C-7 with a metal-tipped screwdriver. Release handset button, remove meters from jacks.

80. If no USFS Type A Test Set is at hand, and an oscilloscope is available with an input circuit which will handle your assigned frequency, the method of paragraph 78 may be used, substituting the tuned oscillograph input circuit for the rectifier wavemeter. In this case the oscillograph input circuit is tuned to resonance with doubler plate coil L-3, instead of the rectifier wavemeter as stated in paragraph 78; also, where paragraph 78 says to adjust for maximum or minimum meter deflection, adjust instead for maximum or minimum amplitude of screen pattern. When neutralization has been completed by this method, check as outlined in paragraph 74.

81. Use of the oscilloscope permits visual check of modulation. The modulation check should be performed with the transmitter working into an antenna or dummy antenna. A suitable dummy antenna is described in paragraph 56.

82. The transmitter should now be checked operating into an antenna or dummy antenna. A suitable dummy antenna is described in paragraph 56. The antenna or dummy load is connected to the "ANT" binding posts. Turn meter switch SW-301 to "TRANS TUNE", press handset button, and tune final-amplifier resonating capacitor C-8 C-9 for minimum final amplifier plate current. If this minimum current is more than 22 ma, loosen coupling between final-amplifier plate coil L-5 and antenna coil L-6, and retune C-8 C-9; if less than 22 ma, increase coupling and re-tune C-8 C-9. Coupling between L-5 and L-6 is adjusted such that final-amplifier plate current is 22 ma when C-8 C-9 is tuned for minimum final-amplifier plate current. If the dummy antenna of paragraph 56 is used, the lamps should glow somewhat less than full brilliance under these conditions. Whistling into microphone should produce an increase in lamp brilliance.

83. Detune final-amplifier resonating capacitor C-8 C-9, so that final-amplifier plate current rises to a high value, but permit this high current to flow only sufficiently long to read the meter. Release handset button. With proper excitation off-resonance final-amplifier plate current should be at least 50 ma; that is, meter should swing off scale. If it is less than this amount, final amplifier VT-3 has insufficient emission, and should be replaced. After replacing, check neutralization by the method of paragraph 74.

84. Although no convenient provision has been made for measuring plate currents of speech amplifier and modulator tubes, it may be noticed that there is some variation of these currents during adjustment of the r-f section of the transmitter. This condition is entirely normal, and results from the fact that bias for modulator VT-4 and speech amplifier VT-5 comes from plate-current drop in R-10. Thus, if plate current to r-f tubes varies, due to adjustments, bias applied to VT-4 and VT-5 will vary somewhat.

85. Turn "ON-OFF" switch "OFF", replace dust cover.

2.2 RECEIVER DATA

2.201 General

86. To provide the ability to receive modulated-oscillator transmitters, such as the Type S, the response of the Type T Model D receiver has been made substantially uniform over a pass band 50 kc wide. The i-f amplifier which provides this characteristic includes 3 amplifier tubes and 4 iron-cored transformers, and has a center frequency of 4050 kc.

87. The achievement of this wide-band uniform-response characteristic depends critically upon the precise adjustment of the 4 transformer couplings and the 8 transformer-tuning capacitors. Due to the large width of the pass band, these adjustments cannot be made by the usual methods, in which tuning adjustments are made by observation of

output-meter indication, or maximum volume in a speaker. It is therefore extremely important that the precise adjustments made at the factory be left undisturbed. If the adjustments are disturbed, it is not possible to correct them without a proper technique, and a specially designed frequency-modulated oscillator and an oscilloscope. The frequency-modulated oscillators which are commercially available for aligning broadcast and short-wave household receivers are not suitable for this job.

88. In view of the above considerations, it is extremely important that in any servicing operation on the Type T Model D receiver, the first thing to do is to locate the trouble by means of instrument tests. In no case should the technician proceed at once to try various adjustments on the receiver to see if an improvement will be realized.

2.202 Locating Trouble

89. If the receiver fails to operate, first follow the procedure of paragraphs 54 to 64 inclusive. If this fails to clear the trouble, proceed as follows:

90. With the receiver turned on, and with meter switch SW-301 turned away from "RECV TUNE", check plate, screen and filament voltages on all tubes. Avoid accidental grounding of plate terminals. Normal tube-element voltages are listed in Table 4. While a 1000-ohms-per-volt meter is satisfactory for measurement of plate and filament voltages, a 20,000-ohms-per-volt instrument is required for measurement of screen, oscillator-anode, and oscillator-grid voltages; also plate voltage of VT-105.

TABLE 4

Normal Voltages to Chassis on Receiver-Tube Plate, Screen, and Filament Terminals

Tube Element	Filament	Plate	Screen	Filament
Socket Terminal No.	2	3	4	7
VT-101	1.5	180	68	3.0
VT-102	1.5	180	135	0
VT-103	1.5	180	135	0
VT-104	3.0	180	135	1.5
VT-105	1.5	110	---	0
VT-106	3.0	162*	105	1.5

*Measured with handset on hook.

91. An abnormal tube-element voltage will suggest the general location of the trouble, and will limit possible faulty components to a few, which may then be checked individually.

92. Check h-f oscillator anode-grid voltage. To make this test, touch minus voltmeter prod to chassis and plus prod to coil side of R-101. Normal voltage at this point is 110 volts.

2.203 Checking the H-f Oscillator

93. The next step is checking the operation of the h-f oscillator. The most convenient method involves indirect measurement of oscillator-grid current by observing the voltage drop across R-102, the oscillator-grid leak. This requires a voltmeter of at least 20,000 ohms per volt. A 1000-ohms-per-volt meter cannot be used.

94. Connect plus prod to chassis, and connect a 1-megohm 1/2-watt resistor to the minus prod point. This register serves as an r-f choke. Select a meter scale such that a deflection of 5 or 10 volts is observable, and such that the internal resistance of the meter is at least 1 megohm. With the 20000-ohms-per-volt meter, the internal resistance is 1 megohm when the meter is switched to the 50-volt scale. With the receiver turned on, touch the free side of the 1-megohm prod resistor to the oscillator-grid terminal on the socket of VT-101 (terminal #5), and note voltmeter reading.

95. It must be remembered that with a 20000-ohms-per-volt meter switched to the 50-volt scale, the meter has an internal resistance of 1 megohm, so the prod resistor will act as an external multiplier, and meter indication must then be multiplied by 2 to get actual voltage. If a very-high-resistance voltmeter is used, such as the RCA "VoltOhmyst" Vacuum-Tube Voltmeter, the same general procedure is used. The scale-multiplying effect of the 1-megohm prod resistor will be less, however, and must be calculated from the input resistance of the device. In any case this factor will be

$$\text{Multiplying Factor} = \frac{\text{Prod Resistance} + \text{Internal Meter Resistance}}{\text{Internal Meter Resistance}}$$

96. If the oscillator is operating properly, the actual voltage across R-102 should be about 10 volts. A corrected reading of at least 8 volts indicates stable oscillation. If the corrected reading is between 4 and 8 volts, oscillations are sufficient for satisfactory receiver operation, but are weaker than desirable. If corrected reading is less than 8 volts, try a new tube for converter VT-101.

97. If no high-resistance voltmeter is at hand, operation of the h-f oscillator may be checked by use of the USFS Type A Test Set. Insert the grid-dip-oscillator coil for the upper frequency range, and switch Test Set for operation as a grid-dip-oscillator. Couple Test-Set coil loosely to anode-grid coil L-104, and tune Test-Set dial to resonance with L-104. If h-f oscillator is not operating, Test-Set meter will simply dip as Test Set is resonated with L-104. If oscillator is operating, however, Test-Set meter will show both a downward and an upward deflection as Test-Set dial is tuned through resonance with L-104. The dial must be tuned very slowly through resonance to make this upward and downward deflection observable.

98. If the test of paragraph 97 shows the h-f oscillator to be inoperative, try a new tube for converter VT-101. Check connections and components associated with h-f oscillator circuit.

2.204 Checking the a-f Amplifier

99. If foregoing tests have not disclosed the source of trouble, the next step is to introduce a signal into the grid of audio amplifier VT-105 to see if the audio portion of the receiver is operating. By then introducing signal into tubes successively closer to the antenna terminals, the approximate location of trouble can be learned by noting at which point of signal-introduction the receiver ceases operation. Detailed instructions follow.

100. Connect a source of a-f voltage across R-117, the volume control. This may be any convenient frequency, such as 400 or 1000 cycles, and should preferably be between 0.01 and 0.1 volt. Turn receiver on, turn "VOLUME" knob all the way to the right, and listen for tone in the handset receiver. If tone is absent, the connections and components in the audio-frequency section of the receiver should be checked. Try a new tube for VT-105.

101. The source of a-f voltage used for this test will depend upon what the technician has available. An a-f generator, such as a beat-frequency oscillator, is satisfactory if used with a suitable attenuator. Some signal generators have provision for 400-cycle output, usually through an attenuator. If no tone generator is available, an ordinary pair of headphones may be used. Connect headphone terminals across R-117. An assistant should talk into the headphones while the technician listens in the handset receiver. If no assistant is on hand, the technician must talk and listen simultaneously. In this case it will be necessary to manipulate the "VOLUME" knob to distinguish whether the speech is being heard through the handset receiver.

2.205 Locating Trouble in i-f Amplifier

102. Next test the portion of the receiver including and following the 3rd i-f amplifier. Apply a modulated i-f signal from a signal generator to the grid of 3rd i-f amplifier VT-104. Grounded side of signal-generator cord is connected to the chassis, and ungrounded side is connected to the grid of VT-104 is series with a .0005 mfd. mica capacitor. Proper grid bias is provided by inserting a 0.5-megohm 1/2-watt resistor between the grid cap and the grid clip from the i-f transformer. A convenient assembly for making these connections is shown in Sec. 12.401 of this handbook. Turn receiver on, adjust frequency of signal generator to 4050 kc, with modulation on signal. Listen in handset receiver while turning up attenuator on signal generator. Adjust frequency of signal generator for loudest signal in receiver, lowering generator output with attenuator as required to prevent overloading in the receiver. If frequency setting on signal generator differs slightly from 4050 kc, it may indicate some inaccuracy in signal-generator calibration, rather than mistune in the i-f transformer. Finally adjust attenuator for a moderate signal in the handset receiver. Note setting of attenuator.

103. If no commercial signal generator is available, the USFS Type D Test Set may be used. Turn "FREQUENCY-SWING" knob all the way to the left, and turn "4025 KC" and "4075 KC" switches off. Plug output cord into "LOW OUTPUT" socket, and connect other end of cord to grid of VT-104 as outlined in paragraph 102. Adjust frequency with "FREQUENCY" knob, and signal level with "ATTENUATOR" and "ATTENUATOR VERNIER" knobs. Proceed as instructed in paragraph 102.

104. If the foregoing procedure has not produced a signal in the handset receiver, try a new tube in VT-104 socket. Search for faulty connections or components in the circuits associated with VT-104.

105. Remove signal-generator cord from VT-104, replace grid clip and top of tube shield.

106. Using the same general procedure as described in paragraphs 102 and 103, successively apply modulated signal from signal generator to grids of VT-103, VT-102, and VT-101. In the case of each stage thus tested, it should be possible to maintain the same output in the handset receiver with attenuator setting well reduced from the final adjustment it had while testing the previously-examined stage. Also, frequency setting of signal generator should be the same during tests of all stages.

107. If, in some stage, the attenuator setting must be raised above the setting it had in the previously-tested stage instead of lowered, for the same apparent output in the handset receiver, then the stage under examination is not operating correctly. If moving signal-generator input from one stage to the next stage forward in the receiver results in disappearance of the signal in the handset receiver, then obviously the stage under test is at fault. Try a new tube in the faulty stage, and examine connections and components associated with the stage in question.

108. Introduce a modulated signal at the operating frequency of the receiver to the antenna coil. Although many signal generators do not operate at frequencies between 32 and 39 Mc, the output of some signal generatorshas sufficient harmonic content to permit use of the 2nd or 3rd harmonic of a lower frequency. The signal may also be ob tained from the Type A Test Set. Insert the coil for operation as a grid-dip oscillator on the 32 to 39 Mc band, and turn switches so that Test Set operates as a modulated oscillator. Couple Test-Set coil very loosely to antenna coil L-101. Tune Test Set to a frequency within the range of the receiver, and tune receiver to the signal thus produced. With no antenna, a good signal should be heard in the handset receiver with the Test Set near L-101. If no output is heard, and if previous tests have disclosed no trouble, the fault is in the input circuit to the receiver. Circuits associated with signal grid of converter VT-101 should be examined for faulty connections or components.

2.206 Alignment of i-f Amplifier

109. On rare occasions it may be necessary to tune one or more i-f transformers, due, for instance, to a replacement of an i-f transformer because of mechanical damage. As pointed out previously, this adjustment requires a specially-designed frequency-modulated oscillator and an oscilloscope. The frequency-modulated oscillators which are commercially available for aligning broadcast and household short-wave receivers are not suitable for this job.

110. If the technician is not thoroughly familiar with the use of this method of aligning tuned circuits, and is not adept at interpreting oscilloscope patterns in terms of circuit mis-adjustments, he should acquire this information before proceeding with alignment of the i-f amplifier. See Rider, John F., The Cathode-Ray Tube at Work, 1935, Ch. 6, John F. Rider, Publisher, 1440 Broadway, New York, N. Y. In any case paragraphs 109 to 118 should be read before starting any aligning.

111. The USFS Type D Test Set is a frequency-modulated oscillator, with a center frequency which may be adjusted to 4050 kc. Oscillator frequency is modulated at a rate of 60 cycles over a frequency range adequate to cover the 50-kc pass band of the i-f amplifier. In addition there are 2 crystal-controlled "channel-marker" oscillators, with frequencies 4025 and 4075 kc, respectively. Outputs of the 3 oscillators are mixed, and supplied to the output cord either directly or through an attenuator. See Sec. 12.302.

112. The oscilloscope may be any good commercial instrument with a screen diameter of 3 inches or more.

2.207 i-f Transformer Response Curves

113. Instruments listed above will produce an image of the i-f amplifier frequency-response curve on the oscilloscope screen. Adjustments are made by visual observation of this image. To aid in the interpretation of the patterns that may be observed, the shapes of several typical curves will be discussed. However, it must be emphasized that some of the curve shapes which depart from the ideal may be the result of any of several circuit mis-adjustments. Thus these sample curves cannot be used to diagnose circuit faults by simply comparing observed image with curves in the book. The curves are given for the purpose of aiding the technician's understanding of circuit performance, so that he will have a basis for using judgment in determining condition of circuits being investigated.

114. When 2 identical tuned circuits are coupled together in the correct degree, and the 2 circuits are tuned to the same frequency, the response curve is similar in shape to Fig. 2a[o]. This curve is characterized by relatively steep sides and substantially flat top. Thus the response is substantially uniform over the rather broad frequency range represented by the flat top. Actual pass-band width in kc depends upon center frequency and design factors. This pass band has been made 50 kc in the Type T, Model D.

[o]For further information, see Terman, F.E., Radio Engineering, 1937, Ch. III, McGraw-Hill Book Co., New York, N. Y.

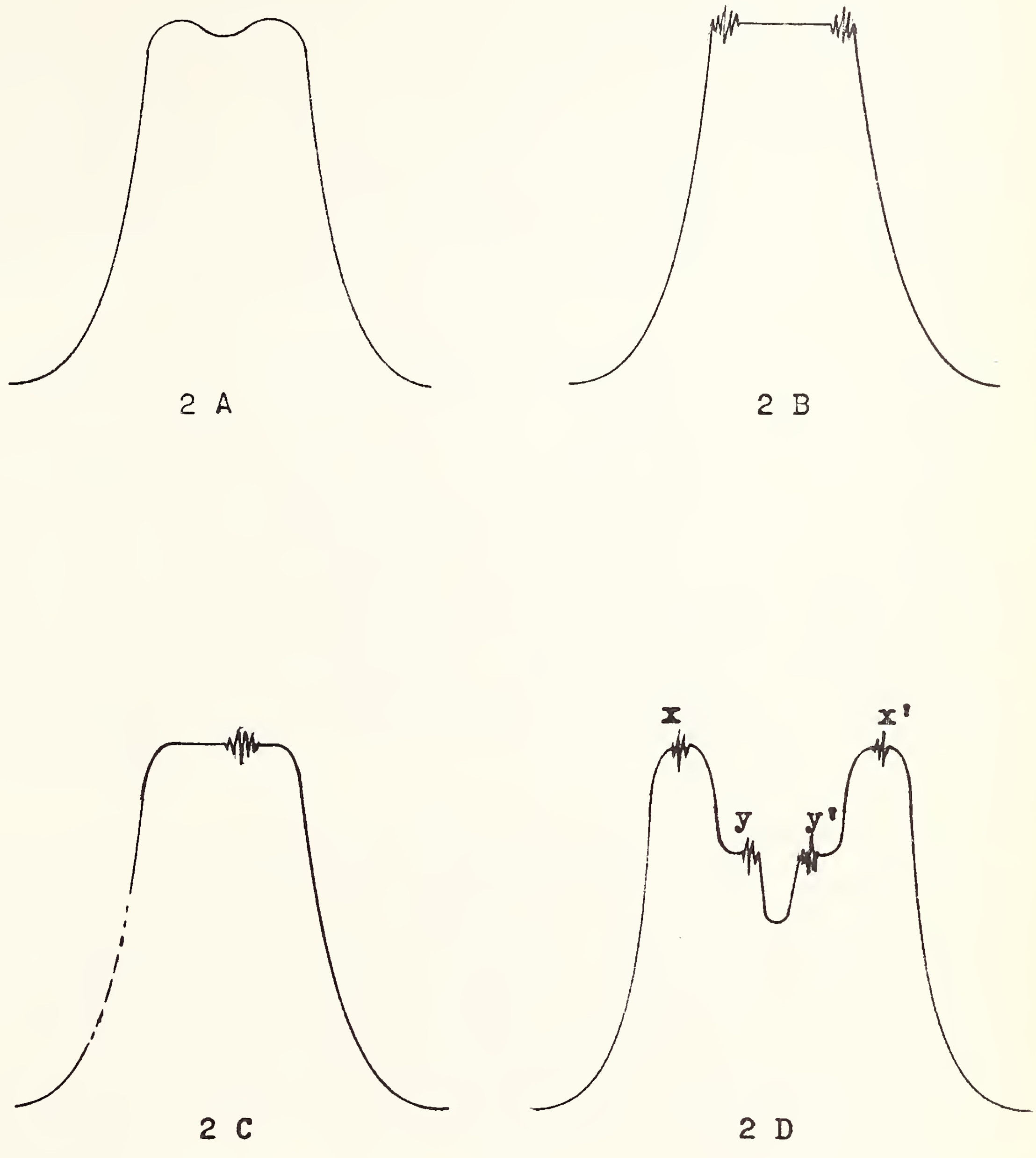


FIG. 2

TYPICAL OSCILLOSCOPE IMAGES

OBSERVED DURING ALIGNMENT PROCEDURE

115. Unless an i-f transformer has been replaced, it may be assumed that the coupling adjustment is correct, and is unchanged from its factory setting. Therefore, aligning operations may be limited to resonating the 2 individual tuned circuits of each transformer to the center frequency of the pass band. Resonating the 2 tuned circuits to a random common frequency is readily accomplished by tuning the compression capacitors at the top of the transformer shield cans until amplitude of observed pattern is highest and has the general flat-topped shape indicated in Fig. 2a. This procedure makes the resonant frequencies of the 2 circuits equal, but does not establish the center frequency at the desired point, namely, 4050 kc.

116. To accomplish this latter requirement, the Type D Test Set has provision for switching 2 additional crystal-controlled "marker" frequencies, 4025 kc and 4075 kc, into the output of the Test Set. If the transformer adjustment is such that center frequency is 4050 kc, and assuming that the pass band is the full nominal 50 kc wide, then the pass band will extend from 4025 kc to 4075 kc. Under these conditions the 4025-kc "marker" frequency will appear on the oscilloscope pattern as a short minor wave superimposed on the main curve at one end of the flat-top portion. Similarly, the 4075-kc "marker" frequency will appear as another minor wave superimposed on the main curve at the other end of the flat-top portion. This is illustrated in Fig. 2b. Fig. 2b is the pattern which results when adjustments are correct, and is the pattern which is sought during the adjustments. The "markers" can be made to appear and disappear by operation of the "4025 KC" and "4075 KC" switches.

117. If a trial adjustment resulted in the center frequency being say 4065 kc; that is, 15 kc high, then the markers would apparently be shifted toward the low-frequency end of the observed response curve, as illustrated in Fig. 2c. The 4075-kc "marker" would apparently have moved from its former position at one end of the flat-top portion toward the center of the curve. The 4025-kc "marker" would have moved off the low-frequency end of the flat-top portion and down the side of the steep portion. It must be realized that the high-frequency end of the response curve is not necessarily the right-hand end of the pattern, as assumed in this discussion. This depends upon which of the 2 twin images is being studied. (See paragraph 128)

118. It should be noted that when the "marker" is moved off the flat-topped portion on to the steep side of the pattern, it no longer appears as a short, minor, superimposed wave. Instead it manifests itself as a series of alternately bright and dim dashes on the steep side. This is illustrated in Fig. 2c. If the "marker" is moved entirely off the steep side of the image, on to the horizontal axis of the pattern, it does not show at all.

119. To determine if one or more i-f transformers are in need of adjustment, each transformer should be checked in order, starting with T-104 and working toward T-101. To make each such check, signal from the Type D Test Set is applied to the grid of the tube preceding the transformer under test. Oscilloscope input is taken from the voltage drop across R-115. A-V-C voltage should be removed during these tests, and a fixed bias supplied in its stead. This fixed bias should be controlled by means of a potentiometer, so the technician can control the gain of the amplifier. Detailed instructions follow.

2.208 Instructions for Producing i-f Response-Curve Image on Oscilloscope

120. Provide a source of bias voltage with which to replace A-V-C voltage. This source may be a 0.5-megohm volume-control-taper potentiometer connected across a 45-volt battery. The connection should be such that voltage measured from plus battery terminal to potentiometer slider increases with rotation slowly at first, and then more rapidly. Thus is, voltage control should have a left-hand taper from the plus terminal of the battery.

121. Disconnect the wire from R-114 to R-115, and connect a 0-25-megohm 1/2-watt resister to the junction of R-114 and C-122. Connect free end of resister to the potentiometer slider. Connect plus end of the potentiometer to the chassis.

122. Connect grounded oscilloscope input terminal to Radiophone chassis. Connect one side of a 0.25-megohm 1/2-watt resister to the junction of R-115 and R-116. Connect the free end of the resister to the ungrounded oscilloscope input terminal. The 2 oscilloscope input leads should be twisted together to avoid pick up from stray a-c fields. The resister serves as an r-f choke.

123. Set oscilloscope controls for 60-cycle linear sweep, and switch on the amplifier for the vertical deflection.

124. Insert output cord of Type D Test Set into "HIGH OUTPUT" socket. In applying signal from Test Set to grid of VT-104, the same instructions may be used as were stated in paragraph 102 for application of signal from a signal generator. The coupling assembly suggested in Sec. 12.401 of this handbook may be used.

125. Turn on receiver. Turn meter switch SW-301 to "RECV TUNE", and adjust grid bias such that meter indicates the approximate reading it would have with receiver operating normally with no received carrier, and with "ANT TRIM" knob resonated. That is, bias should be adjusted so that meter dips about 10 scale divisions below its reading with zero bias.

126. Turn on oscilloscope. Adjust spot for sharpness of line and suitable brilliance, and turn up amplifier gain.

127. Turn "PWR" and "PLATE" switches on Type D Test Set " ON". "ATTENUATOR" knobs have no effect when "HIGH OUTPUT" socket is used. Adjust "FREQUENCY" and "FREQUENCY SWING" knobs until a pattern appears on the screen. Readjust oscilloscope amplifier gain for convenient height of pattern, and readjust sweep-frequency and synchronization controls so that 2 or 3 images of the pattern appear.

128. Turn "FREQUENCY" knob on Type D Test Set slowly, until patterns have just disappeared. As "FREQUENCY" knob is slowly returned, patterns will grow in height, then will widen. As knob rotation is continued, each image will separate into 2 response curves. These are twin images of the same response curve, the left-hand side of one image corresponding to the right-hand side of the other. That is, each of the twin images is a"mirror-reflection" of the other. At this point the "FREQUENCY SWING" knob may be re-adjusted so the 2 twin images are well separated. This is the desired pattern. However this knob must not be turned so far to the right that the internal vibrating capacitor will overswing and rattle. If rotation of the "FREQUENCY" knob is continued, separation between the 2 images will increase, and at length images will merge with others coming in from the sides. Further continued rotation will cause amplitudes to decrease, and finally the patterns will disappear. Reasons for this behavior may be learned from Figs. 262, 263, and 264 in Rider, The Cathode-Ray Tube at Work.

129. With "FREQUENCY" and "FREQUENCY SWING" knobs adjusted so that the 2 twin images are distinct and well separated, re-adjust sweep-frequency and synchronization controls on oscilloscope so that a single pair of twin images occupies the screen. Turn "4025 KC" and "4075 KC" switches "ON". Equipment is now in adjustment for making observations of amplifier characteristics on oscilloscope screen.

2.209 Stage-by-Stage Examination of Transformer Tuning

130. With signal from Type D Test Set connected to grid of 3rd i-f amplifier VT-104, note shape of image and position of "markers". It might be worthwhile to make a rapid pencil sketch showing curve shape and "markers" position.

131. Replace grid clip from i-f transformer T-103 on grid of VT-104, and replace top of shield. Move output cord on Type D Test Set to "LOW OUTPUT" socket, and connect cord terminals to grid of VT-103, using the same instructions as stated in paragraph 124 for applying signal to grid of VT-104. With oscilloscope gain turned to maximum, and without disturbing settings of "FREQUENCY" and "FREQUENCY SWING" knobs, adjust "ATTENUATOR" and "ATTENUATOR VERNIER" knobs for proper height of image on screen. Note shape of curve and positions of "markers". These should be substantially the same as observed when signal input was connected to VT-104.

132. Replace grid clip from T-102 on grid of VT-103, and replace top of shield. Connect Test-Set cord terminals to grid of VT-102, using same instructions as stated in paragraph 131 for applying signal to grid of VT-103. Make the same re-adjustments as instructed in paragraph 131, and again observe curve shape and positions of "markers". These should still be substantially unchanged.

133. Replace grid clip from T-101 on grid of VT-102, and replace top of shield. The procedure for applying signal to grid of converter VT-101 differs from that of the other tubes. Remove top of shield can, but do not remove grid clip from VT-101 grid. Connect one side of a 5000-ohm 1/2 watt non-inductive resistor to grid of VT-101, and clip ungrounded side of Test-Set cord to the free end of this resistor. Connect grounded side of Test-Set cord to chassis.

134. With connections made as described in paragraph 133, signal input circuit to VT-101 will be as shown in Fig. 3. It is seen that signal from the Test Set is applied to the grid of VT-101 through a voltage-divider circuit which includes the 5000-ohm resistor and the impedance of the tuned grid circuit. Since the tuned circuit resonates at the operating frequency of the receiver, it will have a low impedance to the i-f signal from the Test Set. With the 4 amplifier tubes that are now active, amplifier gain is extremely high. The inclusion of the tuned circuit from grid of VT-101 to ground provides a shunt with low impedance to i-f currents, and tends to counteract amplifier instability which might otherwise result from the high gain.

135. Re-adjust "ATTENUATOR" and "ATTENUATOR VERNIER" knobs for proper height of image on screen. Tune the main tuning dial of the receiver, and note that for certain positions of the dial, secondary patterns of higher amplitude appear along with the curve being observed. The secondary patterns can be distinguished from the desired patterns from the fact that secondary patterns can be moved laterally on the screen by adjustment of the tuning dial. The secondary patterns appear when the tuned grid circuit resonates with a harmonic of the signal from the Test Set. The secondary patterns should be removed by turning receiver tuning dial to a position where they do not appear.

136. It will be noted that the curve image has become ragged, and superimposed with irregular minor waves which obscure the "markers". These irregularities are caused by receiver noise. To eliminate them, the gain of the i-f amplifier must be reduced, and the input signal correspondingly increased. With meter switch SW-301 turned to "RECV TUNE", note meter reading corresponding with the d-c grid bias which has been used throughout the tests so far. Increase bias, thereby decreasing gain, and at the same time adjust "ATTENUATOR VERNIER" knob so as to maintain the height of the image in the screen. Continue this process until the irregularities have disappeared, and it is possible to see the "markers" in the screen. Note whether curve shape and positions of "markers" are approximately the same as for previous tests.

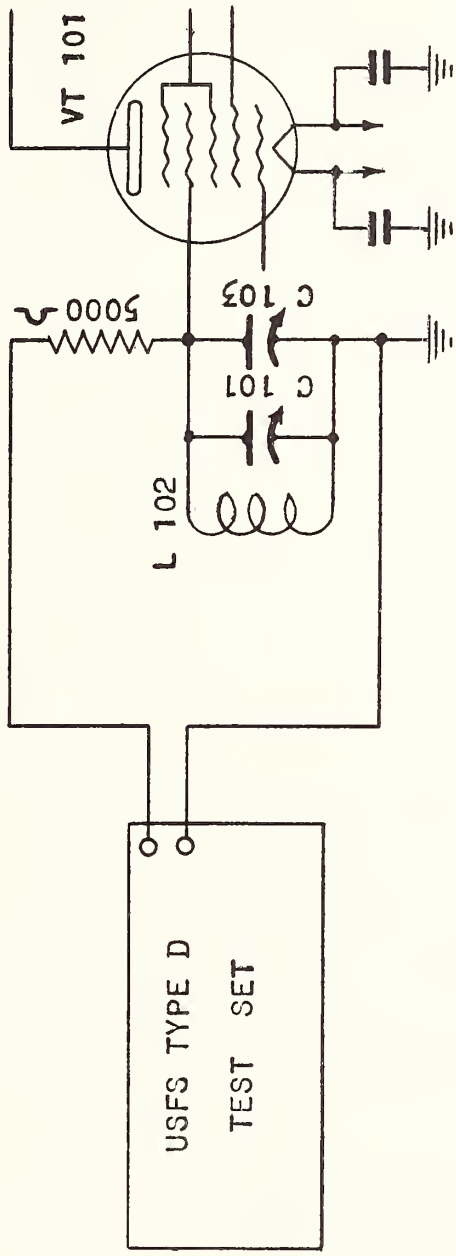


FIG. 3 TEST-SIGNAL INPUT TO VT 101

137. It will be of interest to observe i-f amplifier action with gain returned to its former value. This is done by decreasing d-c grid bias until meter reading returns to its previous value. Decrease signal input from Test Set so that image height is proper. Irregularities due to receiver noise will again be evident. It may be noted that the general shape of the curve is approximately the same with high amplifier gain as with the lower gain, thereby indicating the lack of objectionable regeneration in the i-f amplifier.

138. It will also be of interest to observe the response curve for a signal applied at the operating frequency of the receiver. To make this observation, turn "FREQUENCY" knob on Test Set until the pattern that has been studied disappears. Continue this adjustment until one of the "secondary" images referred to in paragraph 135 appears. As noted above, this image appears when the tuned circuit resonates with one of the harmonics from the Type D Test Set, and may be identified by the fact that such images move laterally on the screen in response to variation of receiver tuning dial. Adjust "ATTENUATOR VERNIER" knob for suitable height of image, and separate the twin images by adjustment of "FREQUENCY" and "FREQUENCY-SWING"knobs. "Markers" will not show on this test. The general shape of the images may be compared with shapes previously observed. It may be noted that width, height, and shape of images vary from moment to moment. This is caused by small variations in a-c line voltage having a slight effect on the degree of frequency-modulation sweep. Due to the high order of the harmonic being used, these slight changes are magnified many times, and appear as the instabilities noted. A little experience will guide the technician in selecting the time when conditions are correct for observation of curve shape. Another observation may be made with Test-Set input connected to "ANT" terminals.

139. The series of observations just completed should now be analyzed. If all curve shapes were substantially identical and flat-topped, and all "markers" appeared at the ends of the flat-topped sections, obviously adjustment of the amplifier is correct and need not be changed. Some slight departures from this idealcan be tolerated. For instance if the several curves are substantially identical and flat-topped, but "markers" are displaced up to 15 kc from the edges of the flat-top section, receiver operation will not be impaired. The amount of this displacement in kc may be judged from the fact that the separation between "markers" corresponds to 50 kc. Fig. 2c is a typical image requlting when the above condition exists.

140. Another entirely normal departure from the ideal is a slight downward dip in the otherwise flat-top portion of the curve. Fig. 2a shows such a dip. Frequently this dip becomes more pronounced as the signal input is moved successively closer to converter VT-101. With i-f signal applied to grid of VT-101, the image will show the characteristic of the entire i-f amplifier. If this characteristic shows departures from the ideal flat-top condition which are small compared with the total amplitude of the image, adjustment of the amplifier may be considered satisfactory.

141. In general, re-alignment will be unnecessary if the following conditions are fulfilled:

(a) The several curves observed are essentially flat-topped and identical.

(b) "Markers" appear at or near ends of flat-top sections.

142. If this series of observations shows acceptable images when input signal is applied to certain stages, but unacceptable images when applied to preceding stages, it is probably necessary to retune the i-f transformer following the stage at which the unacceptable image first appears. For instance, suppose input is successively applied to grids of VT-104, VT-103, and VT-102, and that acceptable images are obtained in the cases of input to VT-104 and VT-103, but not VT-102. After re-checking adjustments on Test Set and connections, it may be assumed that T-102 needs re-aligning.

2.210 Experimental Adjustment of Final i-f Transformer

143. If the foregoing series of tests has shown any stage to be in need of re-alignment, the technician should first connect signal input from the Type D Test Set to 3rd i-f amplifier VT-104, and experiment with tuning i-f transformer T-104. Under these conditions the resulting curve shape will be affected only by the tuning of T-104, the i-f transformer being adjusted.

144. Connect signal from Type D Test Set to grid of i-f amplifier, VT-104, using instructions of paragraph 124. Adjust "FREQUENCY" and "FREQUENCY-SWING" knobs and oscilloscope controls as outlined in paragraph 129. If an acceptable curve is produced, the technician should detune the capacitors associated with T-104 and note the effect on the resulting curve. It will be observed that slight detuning produces great changes in curve shape, as well as decrease in maximum gain indicated. If detuning is carried still further, amplifier gain will further decrease, and a condition may be obtained in which the twin images will start to merge. Under such conditions a curve such as Fig. 2d may be observed, and this curve may exhibit 2 "markers", 4, or none. If any "markers" show, they will be in symmetrical pairs, as X, X', and Y, Y' in Fig. 2d. Turning the "4025 KC" switch "OFF" will delete one pair of "markers", and the "4075 KC" switch the other pair. Thus these switches may be used to indicate whether the twin images have merged into an apparent single image.

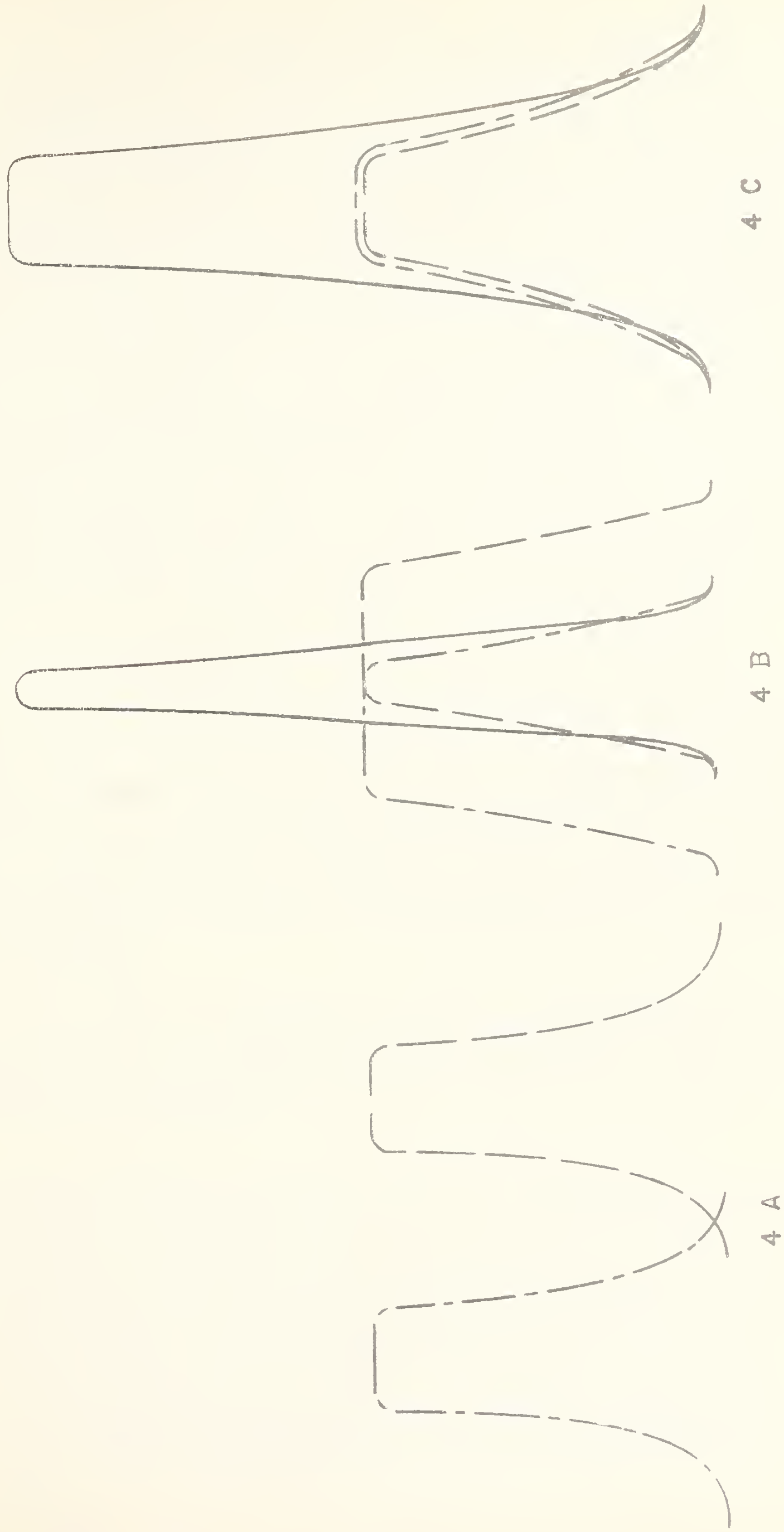


FIG. 4 I-F AMPLIFIER RESPONSE CURVES.

2.211 Retuning Final i-f Transformer

145. To re-tune the i-f transformer, adjust the 2 capacitors associated with the transformer for maximum i-f gain, as indicated by increased height of image on screen. It may be necessary to re-adjust the "FREQUENCY" knob on the Test Set during this process, in such manner as to keep the twin images separated. The 2 capacitors should be re-adjusted several times, alternating from one to the other, until maximum image height is attained. Having achieved this approximate adjustment, the capacitors should be very slightly re-tuned so as to produce the ideal flat-topped curve. By noting positions of "markers" and identifying each "marker" with its frequency, it may be determined whether center frequency of response curve is above or below 4050 kc. A "marker" may be identified as 4025 kc or 4075 kc by noting which switch on the Test Set must be turned "OFF" to make the "marker" vanish. Both capacitors should then be turned in the same direction in such manner as to maintain the shape of the response curve, and to cause the center frequency to approach 4050 kc. Capacitor adjustments should be made alternately, and in very slight amounts, so as not to depart too far from the flat-top characteristic already attained. When center frequency of curve is approximately 4050 kc, as indicated by positions of "markers", carefully adjust capacitors in very slight amounts for ideal curve shape.

2.212 Retuning Preceding i-f Transformers

146. The next step is the re-tuning, if necessary, of i-f transformer T-103. It must be realized that when signal is applied to the grid of 2nd i-f amplifier VT-103, amplified signal passes successively through i-f transformers T-103 and T-104. The overall amplification characteristic as viewed in the oscilloscope will therefore be the product of the individual characteristic curves of the separate transformers. That is, the amplification observed at some particular frequency will be the product of the individual amplifications of the 2 stages at that same frequency.

147. Figs. 4a, 4b, and 4c show 3 of the many possible conditions which may exist in 2 stages of the i-f amplifier. In each figure, individual response characteristics of the 2 stages are shown by dotted and dot-dash lines, respectively, Solid lines show resulting overall performance of the 2 stages.

148. In Fig. 4a each of the 2 i-f transformers has been tuned so that an ideal flat-top characteristic is obtained. However individual center frequencies are so far apart that there is no single frequency which is amplified by both stages. Thus there can be no normal output, and no curve will show on the screen. Use of the crystal controlled "marker" frequencies eliminates this possibility when the Type D Test Set is used for alignment purposes.

149. Fig 4b illustrates an adjustment in which individual stages are again tuned for ideal shape of response curve. In this case

center frequencies of individual transformers are closer so that some frequencies are amplified by both stages. However, the remaining frequencies are passed by only one stage. The resulting overall characteristic is seen to include only the frequencies which are amplified by both stages. If the i-f amplifier in the Type T receiver were adjusted in this manner, the pass band would be inadequate.

150. Fig. 4c shows the correct adjustment, in which individual curves are each properly shaped, and in which center frequencies are identical. In this instance only resulting overall characteristic has the same general shape as the individual characteristics of the separate stages, and the i-f transformer will perform properly.

151. The same discussion applies to the aligning of i-f transformers T-102 and T-101. For these cases the dotted curves of Figs. 4a, 4b, and 4c may apply to the previously-adjusted portion of the amplifier, including 2 or 3 stages, while the dot-dash curve will then apply to the stage being adjusted.

152. To adjust i-f transformer T-103, move signal input to grid of 2nd i-f amplifier VT-103, using "LOW OUTPUT" socket on Test Set for output cord, and using the same instructions as stated in paragraph 131 for applying signal to grid of VT-103. Adjust controls on Test Set as previously outlined for production of twin images on screen. If capacitors of T-103 are far out of tune, as might be the situation with a newly-installed transformer no image may be obtained at first, due to adjustments on the new transformer being similar to those shown in Fig. 4a. In this case the technician should make a trial adjustment of one of the capacitors, and tune the second capacitor over its entire range, searching for an adjustment which will produce some sort of image on the screen. If no image is obtained, another trial adjustment should be made on the first capacitor, and the second capacitor should again be tuned over its range. After a few trials an image will appear.

153. When an image has been obtained, the 2 capacitors on T-103 should be carefully adjusted to produce the ideal flat-top curve with "markers" at the edges of the flat-top portion. This adjustment may be achieved readily by making alternate minute changes in the 2 capacitors.

154. Procedure for tuning T-102 and T-101 is similar. In each case input signal should be applied to the tube preceding the transformer being tuned, using the instructions previously stated in paragraphs 132 and 133, respectively, for applying input signal.

2.213 Effect of Coupling on i-f Transformer Response

155. In view of the fact that a replaced i-f transformer may require adjustment of coupling, the effect of coupling on frequency-response characteristic will be discussed.

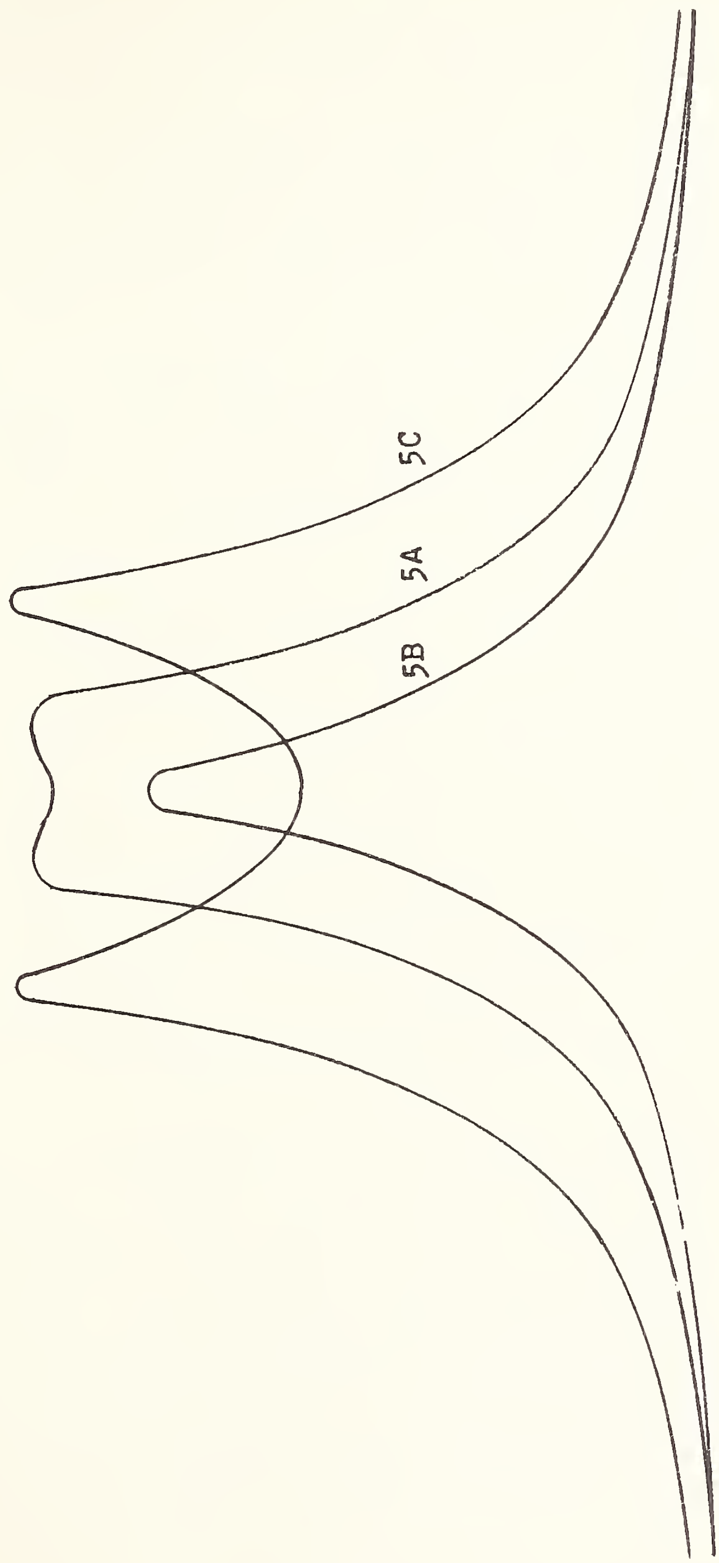


FIG. 5 I-F TRANSFORMER RESPONSE CURVE, SHOWING EFFECTS OF OVER AND UNDER COUPLING

156. When 2 identical tuned circuits are coupled together in the correct degree, and the 2 circuits are tuned to the same frequency, the response curve is similar in shape to Figs. 2a and 5a. As noted in paragraph 114, this curve is characterized by relatively steep sides and flat top. Thus the response is substantially uniform over the rather broad frequency range represented by the flat top.

157. If individual resonant frequencies of the 2 tuned circuits are left equal, and coupling is loosened from the correct amount, the response curve will have a sharper peak and will show less gain. The looser the coupling, the sharper will be the peak and the smaller the gain. A typical response curve in which the coupling is too loose is shown in Fig. 5b.

158. If individual resonant frequencies of the 2 tuned circuits are left equal, and coupling is tightened from the correct amount, the resulting over-coupled condition is illustrated by the response curve of Fig. 5c. It will be noted that the width of the pass band is increased, but the uniformity of response within the pass band is impaired. The greater the degree of over-coupling, the more severe these effects will be.

159. Obviously, for proper receiver operation, the degree of coupling in each transformer must be correct.

2.214 Adjustment of i-f Transformer Coupling

160. I-f transformer coupling is adjusted by means of a hexagonal nut accessible through the side of the shield can. Before applying a socket wrench to this nut, it is necessary to loosen the 2 set screws which are accessible through holes in the chassis. These set screws in turn are locked by smaller hex nuts, which may be loosened with a socket wrench. Set screws must be loosened before attempting to rotate coupling nut, or the fragile bakelite frame of the transformer may be broken. Avoid excessive turning force on adjustment of nut. The wrench should be held in the tips of the fingers, and turning force must not be applied after the nut stops turning freely.

161. Procedure for adjusting coupling nut follows. First check to see that adjustment is correct in all i-f transformers following the one in which coupling is being adjusted, using instructions in paragraphs 119 to 136, inclusive. Following directions of paragraphs 145 to 154, inclusive, try tuning capacitors on transformer in which coupling is being adjusted so that ideal flat-topped curve results. If coupling is too loose, no settings of capacitors will produce a response curve with the full width of the flat top between the "markers". The top will be narrower, and will tend to be peaked. If coupling is too tight, an excessive depression will appear in the middle of the otherwise flat-topped portion. Adjust coupling until proper tuning of transformer capacitors produces an ideal flat-topped curve with properly positioned "markers".

162. When adjusting coupling on a new transformer, it may be found on rare occasions that no combination of coupling and capacitor settings produces a flat-topped curve, but instead one side of the curve persists in showing a sharp peak. This may be the result of reversed winding connections inside the transformer. Remove transformer from shield can, and compare connections of coils to the variously-colored leads and also coil-winding directions with those in the old transformer which is being replaced. If a difference is found, change connections on new transformer to correspond with those in the old one.

163. When adjustments have been completed, re-connect the wire from R-114 to R-115. Remove leads to grid-bias supply and oscilloscope and replace dust cover.

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Oscillator tuning	25 MMF variable	Hammarlund	APC-25 Special Double-spaced Cadmium plated
C2	Doubler grid blocking	.0005 MFD mica	(Aerovox (Solar	1467) MW-1222) *
C3	Oscillator plate return bypass	.001 MFD mica	(Aerovox (Solar	1467) MW-1227) *
C4	Doubler tuning	25 MMF variable	Hammarlund	APC-25 special Double-spaced Cadmium plated
C5	Doubler plate return bypass	.0005 MFD mica	(Aerovox (Solar	1465) MT-1322) *
C6	Final neutralizing	Variable special	Hammarlund	APC-25 Special Double spaced Cadmium plated Reduced to 5 plates
C7	Final neutralizing	Variable special	Hammarlund	Identical with C6
C8) C9)	Final amplifier tuning	15 MMF Variable	Hammarlund	HFD-15-X
C10	Final amplifier grid return bypass	.0005 MFD mica	(Aerovox (Solar	1468) MO) *
C11	Speech amplifier degeneration coupling bypass	.1 MFD 400-V paper	Solar	MP-4147 *
C12	Speech amplifier screen bypass	.1 MFD 400-V paper	Solar	MP-4147 *
C13	Speech amplifier grid return bypass	.1 MFD 400-V paper	Solar	MP-4147 *
C14	Microphone bypass	.001 MFD 600-V paper	Mallory	TP-404

*Or equivalent

2.51 Capacitors (Cont.)

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C101	Antenna tuning	12 MMF variable)	Hammarlund	HFD-15-X, each section reduced to 5 rotor and 4 stator plates
C102	H-F Oscillator tuning	12 MMF variable)		
C103	Antenna trimming	Variable	Hammarlund	HF-15, reduced to 2 plates
C104	Anode grid return bypass	.0005 MFD mica	(Aerovox (Solar	1468) MO) *
C105	Converter filament bypass	.01 MFD 600-V paper	Solar	S-0221 *
C106	Converter filament bypass	.01 MFD 600-V paper	Solar	S-0221 *
C107	Converter screen bypass	.01 MFD 600-V paper	Solar	S-0221 *
C108	Converter plate return bypass	.01 MFD 600-V paper	Solar	S-0221 *
C109	1st I-F Amplifier grid return bypass	.01 MFD 600-V paper	Solar	S-0221 *
C110	1st I-F Amplifier filament bypass	.01 MFD 600-V paper	Solar	S-0221 *
C111	1st I-F Amplifier screen bypass	.01 MFD 600-V paper	Solar	S-0221 *
C112	1st I-F Amplifier plate return bypass	.01 MFD 600-V paper	Solar	S-0221 *
C113	2nd I-F Amplifier grid return bypass	.01 MFD 600-V paper	Solar	S-0221 *
C114	2nd I-F Amplifier filament bypass	.01 MFD 600-V paper	Solar	S-0221 *
C115	2nd I-F Amplifier screen bypass	.01 MFD 600-V paper	Solar	S-0221 *
C116	2nd I-F Amplifier plate return bypass	.01 MFD 600-V paper	Solar	S-0221 *
C117	3rd I-F Amplifier filament bypass	.01 MFD 600-V paper	Solar	S-0221 *
C118	3rd I-F Amplifier filament bypass	.01 MFD 600-V paper	Solar	S-0221 *

* Or equivalent.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C119	3rd I-F Amplifier screen Bypass	.01 MFD 600-V paper	Solar	S-0221 *
C120	3rd I-F Amplifier plate return bypass	.01 MFD 600-V paper	Solar	S-0221 *
C121	Diode detector return bypass	.0001 MFD mica	(Aerovox (Solar	1465) MT-1316) *
C122	A-V-C Bus bypass	.01 MFD 600-V paper	Solar	S-0221 *
C123	Volume control blocking	.01 MFD 600-V paper	Solar	S-0221 *
C124	Audio amplifier plate blocking	.01 MFD 600-V paper	Solar	S-0221 *
C125	Buzzer filter	.01 MFD 600-V paper	Solar	S-0221 *
C126	Alarm tube grid	.05 MFD 400-V paper	Solar	S-0228 *
C127	H-F Oscillator grid	.00005 MFD mica	(Aerovox (Solar	1468) MO-1410) *
C128	Plate battery bypass	.01 MFD 600-V paper	Solar	S-0221
C129	Antenna Series	.00004 MFD mica	(Aerovox (Solar	1465) MT-1308) *

*Or equivalent

2.52 Inductors

SYMBOL	COMPONENT	DESCRIPTION
L1	Oscillator plate	14 turns #26 enameled wire, tapped 5 turns from grid end, wound on national type XR-3 form, threaded 40 turns per inch.
L2	Oscillator grid	7 turns #26 enameled wire, wound on same form with L1, threaded 40 turns per inch. L2 is adjacent to ground end of L1.
L3	Doubler plate.	7 turns #22 enameled wire, wound on national type XR-3 form, threaded 20 turns per inch.

2.52 Inductors (Cont.)

SYMBOL	COMPONENT	DESCRIPTION
L4	Final amplifier grid	10 turns #28 enameled wire, center tapped close wound in same direction as L3 on paper form fitted inside L3. For transmitters operating above 38 MC, L4 is 9 turns, center tapped.
L5	Final amplifier plate	12 turns #16 enameled wire, self supporting, inner diameter 11/16". Wound in 2 halves, each half 1/2" long. Separation between halves, 7/32".
L6	Antenna	2 turns #18 enameled wire, self supporting, inner diameter 5/8". Close wound.
L101	Antenna	1 turn #20 hook-up wire wound over ground end of L102
L102	Converter grid	9 turns #22 enameled wire wound on national type XR-3 form, threaded 18 turns per inch
L103	H-F Oscillator grid	4 turns #28 enameled wire, wound between turns of L104 on grounded end of L104. Wound on amphenol type #24 form threaded 10 turns per inch
L104	H-F Oscillator plate	6 complete turns and 1 compensating turn #24 enameled wire wound 10 turns per inch on same form with L103
RFC-101 to RFC-106, incl.	R-F Chokes	Each choke uses a 1/2-watt 1 RC type BT½ resistor of at least 50,000 ohms resistance for the form. A single layer of #32 enameled wire is wound over the resistor, and ends of winding are connected to resistor leads. Small slots are made in ends of resistor to keep wire from slipping. Resistance of winding, 0.7 ohms.

2.53 Resistors

SYMBOL	COMPONENT	RATING		MANUFACTURER	TYPE
R1	Oscillator grid leak	25,000 ohms	1/2 watt	IRC	BT-1/2
R2	Oscillator plate return filter	500 "	1/2 "	"	BT-1/2
R3	Doubler grid leak	0.25 megohm	1/2 "	"	BT-1/2
R4	Doubler plate return filter	500 ohms	1/2 "	"	BT-1/2
R5	Final amplifier grid leak	3,000 ohms	1/2 "	"	BT-1/2
R6	Speech amplifier screen dropping	20,000 "	1/2 "	"	BT-1/2
R7	Speech amplifier degen-eration coupling	0.1 megohm	1/2 "	"	BT-1/2
R8	Speech amplifier degen-eration coupling	25,000 ohms	1/2 "	"	BT-1/2
R9	Speech amplifier grid return filter	1 megohm	1/2 "	"	BT-1/2
R10	Speech amplifier and modulator bias	75 ohms	1 "	"	2 150-ohm BW-1/2 resistors in parallel
R11	Transmitter filament rheostat	2 ohms	Variable	Mallory	Q
R12	Ballast tube compensat-ing	100 ohms	"	"	C-100-R
R13	Ballast tube compensat-ing	50 ohms	1/2 watt	IRC	BW-1/2
R14					
R15	Microphone current limit-ing	25 ohms	1/2 watt	IRC	BW-1/2

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R101	H-F Oscillator Anode grid voltage dropping	30,000 ohms 1/2 watt	IRC	BT-1/2
R102	H-F Oscillator grid leak	0.1 megohm 1/2 "	IRC	BT-1/2
R103	Converter screen voltage dropping	0.1 " 1/2 "	"	BT-1/2
R104	Converter plate return filter	1,000 ohms 1/2 "	"	BT-1/2
R105	1st I-F Amplifier grid return filter	0.5 megohm 1/2 "	"	BT-1/2
R106	1st I-F Amplifier screen filter	1,000 ohms 1/2 "	"	BT-1/2
R107	1st I-F Amplifier plate return filter	1,000 ohms 1/2 "	"	BT-1/2
R108	2nd I-F Amplifier grid return filter	0.5 megohm 1/2 "	"	BT-1/2
R109	Alarm tube sensitivity control	0.1 megohm variable carbon	Mallory	Y-100-MP
R110	2nd I-F Amplifier screen filter	1,000 ohms 1/2 watt	IRC	BT-1/2
R111	2nd I-F Amplifier plate return filter	1,000 ohms 1/2 "	"	BT-1/2
R112	3rd I-F Amplifier screen dropping	0.15 megohm 1/2 "	"	BT-1/2
R113	3rd I-F Amplifier plate return filter	1,000 ohms 1/2 "	"	BT-1/2
R114	A-V-C Bus filter	0.5 megohm 1/2 "	"	BT-1/2
R115	Diode detector load	0.5 " 1/2 "	"	BT-1/2
R116	R-F Filter	50,000 ohms 1/2 "	"	BT-1/2
R117	Volume control	0.5 megohm variable	Mallory	N
R118	Audio amplifier plate filter	0.25 " 1/2 watt	IRC	BT-1/2

2.53 Resistors

SYMBOL	COMPONENT	RATING		MANUFACTURER	TYPE
R119	Alarm tube grid leak	10 megohm	1/2 watt	IRC	BT-1/2
R120	Alarm tube screen voltage divider	50,000 ohms	1/2 "	"	BT-1/2
R121	Alarm tube screen voltage divider	0.1 megohm	1/2 "	"	BT-1/2
R122	Alarm relay holding	0.1 "	1/2 "	"	BT-1/2
R123	Buzzer filter	100 ohms	1/2 "	"	BW-1/2
R124	I-F Amplifier plate and screen return	1,000 ohms	1/2 "	"	BT-1/2
*R125	Filament series	12.5 ohms	1 "	"	2 25-ohm) BW½ resistors) Note 1 in parallel)
R301	50-MA Meter shunt	Special		Simpson	Ordered with milliammeter
R302	200-volt Meter multiplier	Special		Simpson	Ordered with milliammeter
R303	5-volt Meter multiplier	Special		Simpson	Ordered with milliammeter

Note: To re-order R301, R302, or R303, send milliammeter together with bakelite sheet supporting shunt and multipliers to service headquarters.

2.54 Tubes

VT1	Oscillator	Sylvania	1H4G
VT2	Doubler	Sylvania	1H4G
VT3	Final amplifier	Sylvania	1J6G
VT4	Modulator	Sylvania	1J6G
VT5	Speech amplifier	Sylvania	1F5G

*Note 1: In Models DA and subsequent

2.54 Tubes (Cont.)

SYMBOL	COMPONENT	MANUFACTURER	TYPE	
VT101	Converter	Sylvania	1A7G	
VT102	1st I-F Amplifier	Sylvania	1N5G	
VT103	2nd I-F Amplifier	Sylvania	1N5G	
VT104	3rd I-F Amplifier	Sylvania	1N5G	
VT105	Detector and audio amplifier	Sylvania	1H5G	
VT106	Alarm tube	Sylvania	1N5G	
*VT201	Transmitter ballast	Sylvania	1F1	Note 2

2.55 Transformers

T1	Microphone	Phelps-Dodge	INCA 8028
T2	Modulator driver	Phelps-Dodge	INCA 8027
T3	Modulation	Phelps-Dodge	INCA 8029
T101	1st I-F	Aladdin	A-3500
T102	2nd I-F	Aladdin	A-3500
T103	3rd I-F	Aladdin	A-3500
T104	Diode	Aladdin	A-3502
T105	Receiver output	Phelps-Dodge	INCA 8030

2.56 Switches

*SW1	Microphone push-to-talk	(H & H (Special	3391A	Note 3 Note 4
SW101	Alarm standby on-off handset hook	Special		
SW201	Rheostat - ballast tube selector	Mallory	8	
SW202	Radiophone on-off	H & H	DPST short-handled toggle nickel plated with short shank	
SW301	Meter, 3P4T	Mallory	3234J	

2.57 Terminal Strips

Description		
Telephone line and extension alarm connection	Cinch	1775

*Note 2: 1C1 ballast tubes were supplied in some sets.

2.58 Batteries

QUANTITY	USE	MANUFACTURER	TYPE
A. Heavy-Duty (Standby Service)			
1	"A" Battery	Eveready	X-125
		Burgess	20-F-2
4	"B" Batteries (4 of 1 type)	Burgess	21308
		General	V-30-FL
		Eveready	386
B. Medium-Duty (Intermittent Service)		(Series - Parallel connected; see "Instructions for Operation")	
4	"A" Batteries (4 of 1 type)	General	#6 dry cell
		Eveready	7111
		Eveready	#6 Ignitor cell
4	"B" Batteries (4 of 1 type)	General	V-30-B
		Eveready	762-S or 762
		Burgess	5308

2.59 Miscellaneous

QUANTITY	SYMBOL	DESCRIPTION	MANUFACTURER	TYPE	
1		Case, Handset	Spokane Radio	(Cast aluminum	Note 3
				(Pressed steel	Note 4
1		Headphone	(Trimm	111 X 1	Note 3
			(Western Electric	HA-1	Note 4
1		Microphone	(Stromberg-Carlson	24562	Note 5
			(Western Electric	F-1	Note 6
1		Cord, Handset	Western Electric	D5J-9	
1	P-1	Plug, Handset cord, with cable clamp	Amphenol	PM5-11	
1	S-1	Socket, handset cord	Amphenol	MIP-5	
1		Cable, battery, 6 ft. Battery end fitted with lugs for binding posts and aluminum stamped markers.	Lenz	4-conductor battery cable per Lenz shop order 98304, mfd. for U.S. Dept. Agri., Forest Service.	
1	P-2	Plug, battery cable	Jones	Standard 5-prong plug for PM-5C socket, with rubber sleeve.	

Note 3: In Model D only
Note 4: In Models DA and subsequent
Note 5: In serial nos. T-310 to approximately T-354
Note 6: In serial nos. approximately T-355 and higher

2.59 Miscellaneous (Cont.)

QUANTITY	SYMBOL	DESCRIPTION	MANUFACTURER	TYPE
1	S-2	Socket, battery cable	Jones	PM-5C socket with bevel for 1/16" with nut and bakelite back piece
1		Crystal, in holder	Bliley	FS,"C"-cut, ground to exactly one-half of transmitter frequency
*1		Milliammeter, 0-5 MA, with special 0-50 scale. Meter specified for installation in 0.050" steel panel.	Simpson	Model 125-S, 0-50 DC milliammeter with subpanel assembly spec. 2,3,4, revised
1	Relay-1	Relay, Transmit-Receive	Guardian	15-25-G2 2-3 volts
1	Relay-2	Relay, buzzer alarm	Sigma	Model 3-A--8000 ohms
1		Buzzer	Edwards	Lungen #15, size #1
1	J-1	Jack, Oscillator plate-current metering	Mallory	432
1	J-2	Jack, Doubler grid-current metering	Mallory	432
1	J-3	Jack, Doubler plate-current metering	Mallory	432
1	J-4	Jack, final-amplifier grid - current metering	Mallory	432
1	J-5	Jack, final amplifier plate -current metering	Mallory	432
1		Socket, 4-prong	Amphenol	MIP-4
2		Sockets, 5-prong	Amphenol	MIP-5
7		Sockets, 8-prong octal	Amphenol	MIP-8
3		Sockets, 8-prong octal low-loss	Amphenol	54-8

QUANTITY	SYMBOL	DESCRIPTION	MANUFACTURER	TYPE
1		Bearing Assembly for Adjustment of Transmitter Antenna Coupling	Bud or Johnson	531 256
4		Shields, Tube	Bud	391
1		Dial, Receiver Tuning	National	BM-1
3		Knobs	Mallory	368
1		Knob, Meter Switch	Mallory	366
3		Points, Tie, 1-Terminal	Bud	367
9		Points, Tie, 2-Terminal	Bud	368
2		Points, Tie, 3-Terminal	Bud	369
2		Posts, Binding, X-L Push-Post Marked "ANT"	X-L	ANT

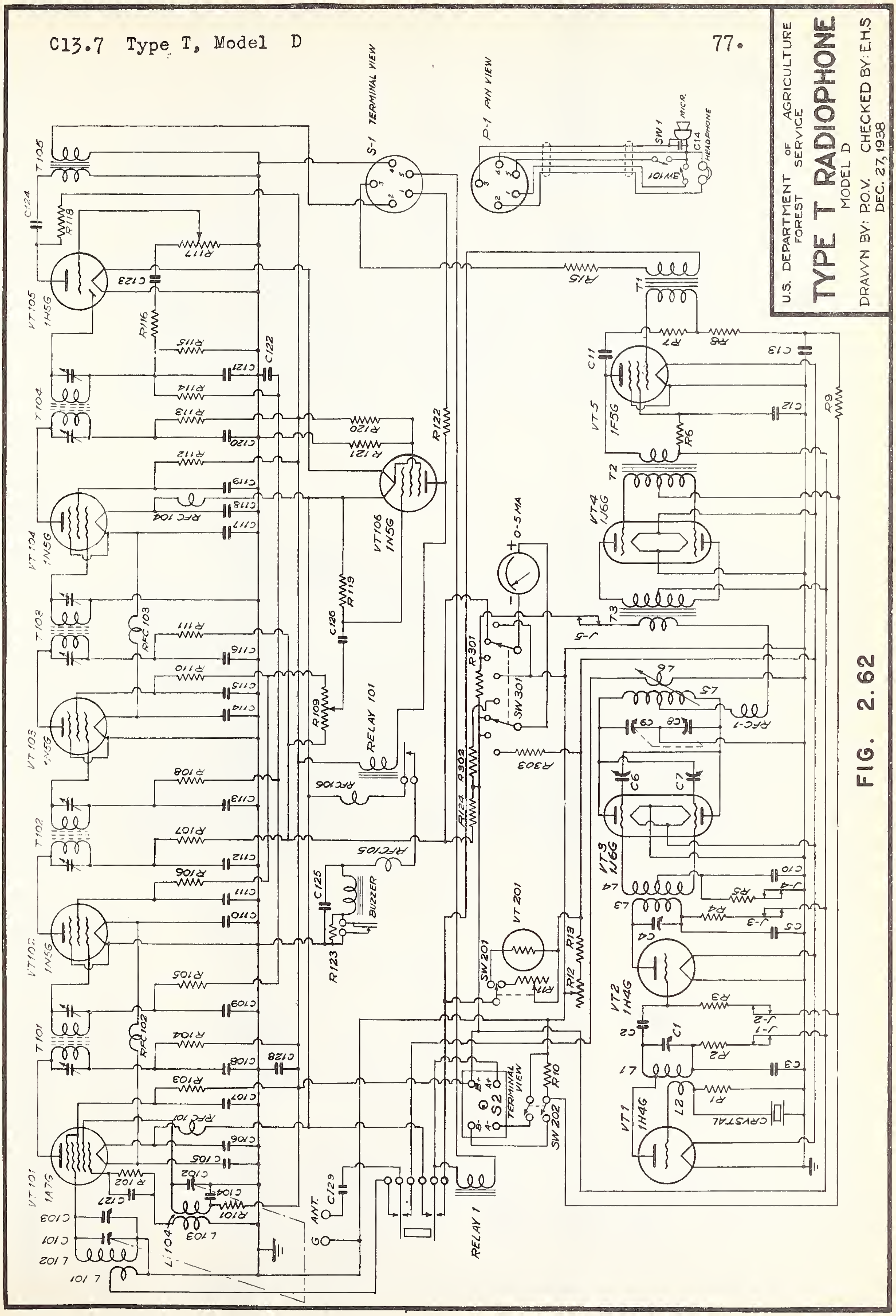

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE T RADIOPHONE
MODEL D
DRAWN BY: P.O.V. CHECKED BY: E.H.S
DEC. 27, 1938
S-1 TERMINAL VIEW
P-1 PIN VIEW
RELAY 101
RELAY 1
BUZZER
CRYSTAL
0-5 MA
ANT.
VT 101 1A7G
VT 102 1N5G
VT 103 1N5G
VT 104 1N5G
VT 105 1H5G
VT 106 1N5G
VT 1 1H4G
VT 2 1H4G
VT 3 1J6G
VT 4 1J6G
VT 5 1F5G
VT 201
MICR.
HEADPHONE

FIG. 2.62

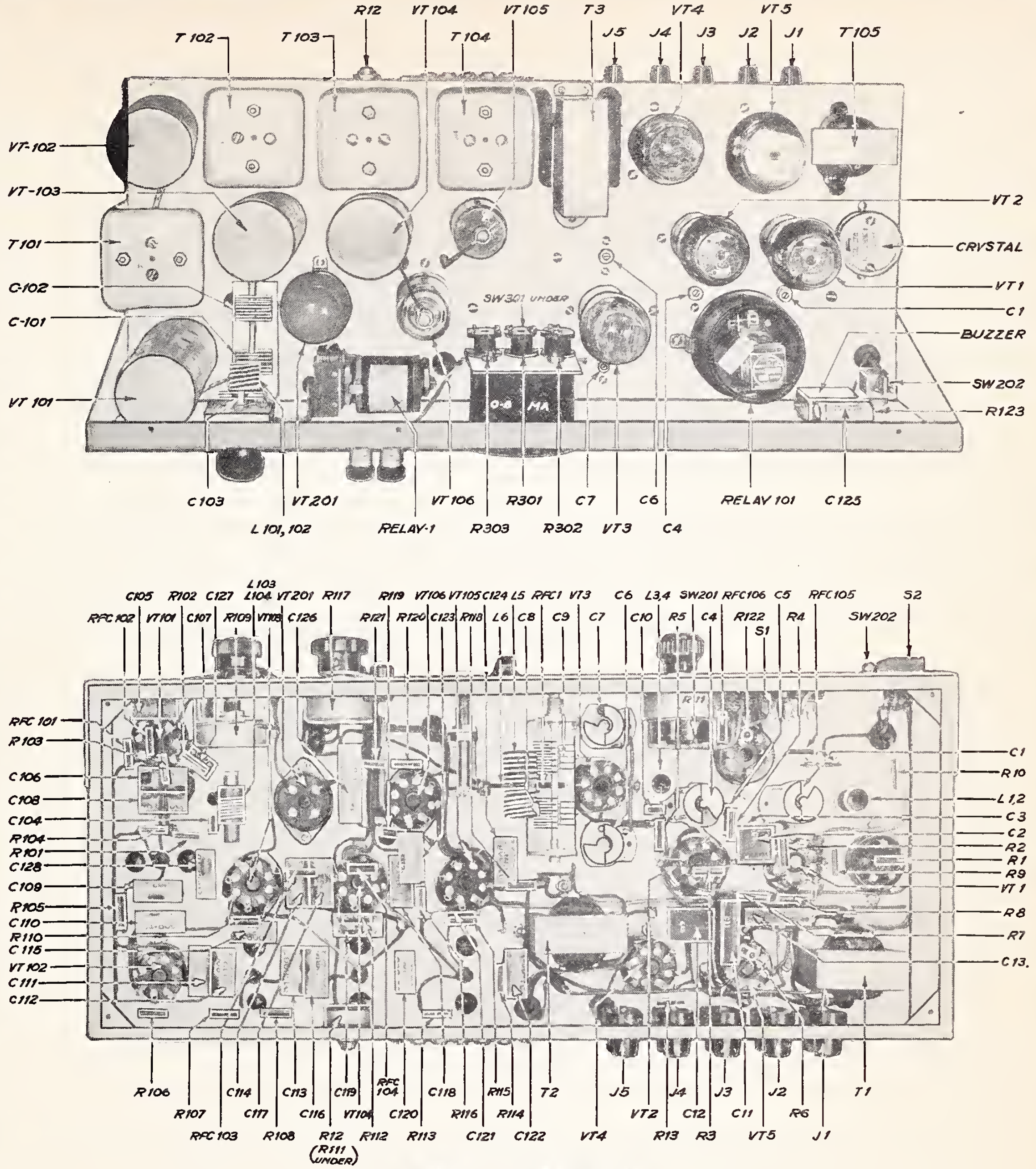
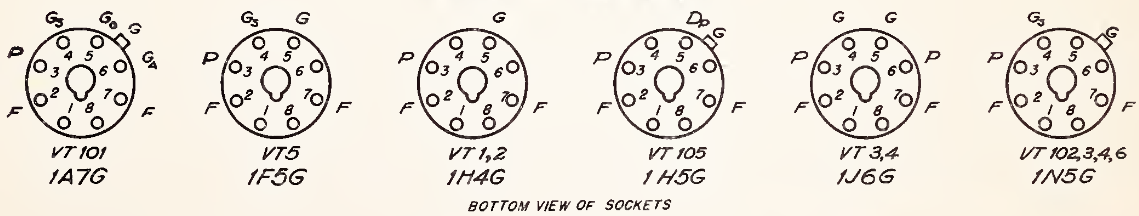
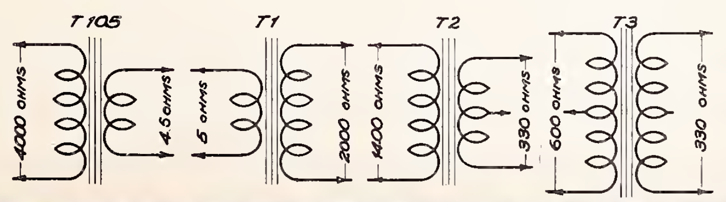


FIG. 2.63





U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE T RADIOPHONE
MODEL D

DRAWN BY: P.O.V. CHECKED BY: E.H.S.
FEBRUARY 13, 1939

2.7 ADDITIONAL DATA

2.71 Speaker Unit

The speaker unit for the Type T Radiophone, Model D, is intended for standby receiver operation. In certain applications the radiophone is subject to interference from heavy vehicular traffic. Ignition interference may cause frequent false operation of the "silent standby" buzzer and thereby limit the usefulness of the call buzzer. For such installations the speaker and its built-in amplifier provide the operator with a means of receiver standby.

All necessary connections are made by removing the handset plug and battery-cable plug from the radiophone and inserting them into receptacles on the speaker unit. The short stub cords on the speaker unit are then plugged into the receptacles on the radiophone. A panel switch on the speaker unit permits the operator to select either speaker standby or silent call-buzzer standby operation. During contacts the operator may use either the speaker or the earphone.

Additional battery consumption is 50 milliamperes of "A" current and 2 milliamperes of "B" current. Cabinet dimensions are 6-1/4" wide x 7" high x 7-1/8" deep. Weight is 6 lbs. 11 oz.

Parts List

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C151	Feedback circuit blocking capacitor	0.1 mfd 400-v paper	Solar	S-0238
R151	Feedback circuit voltage divider resistor	0.5 megohm, 1/2 watt	IRC	BT-1/2
R152	Feedback circuit voltage divider resistor	0.25 megohm, 1/2 watt	IRC	BT-1/2
R153	Filament dropping resistor	30 ohms, 1 watt	IRC	BW-1
VT107	Audio amplifier tube		Sylvania	1N5G
T106	Audio transformer		Phelps-Dodge	Inca 06985
T107	Output transformer		Oxford-Tartak	1290
SW102	Speaker - earphone switch		H & H	DPDT toggle short shank nickel-plated
SW203	On-off switch		H & H	DPST toggle short shank nickel-plated
	Speaker, 5-inch P-M dynamic		Jensen	PM-5-DS
	Cable, battery, 15 inches		Lenz	5-conductor battery cable per shop order 98304, mfd for USDA, Forest Service
P104	Plug, battery cable		Jones	Std 5-prong plug for PM-5C socket, with rubber sleeve
S102	Socket, battery cable		Jones	PM-5C with bevel for 1/16" with nut and bakelite back piece

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
	Cable, microphone and speaker-signal, 12 inches		Lenz	5-conductor battery cable, per shop order 98304, mfd for USDA Forest Service
P101	Plug, microphone and speaker-signal cable		Amphenol	PM5-11
S103	Socket, handset cable		Amphenol	MIP-5
	Socket, tube		Amphenol	MIP-8
	Clip, grid		National	8
	Feet, chassis, felt (4 required)		ARHCo	169

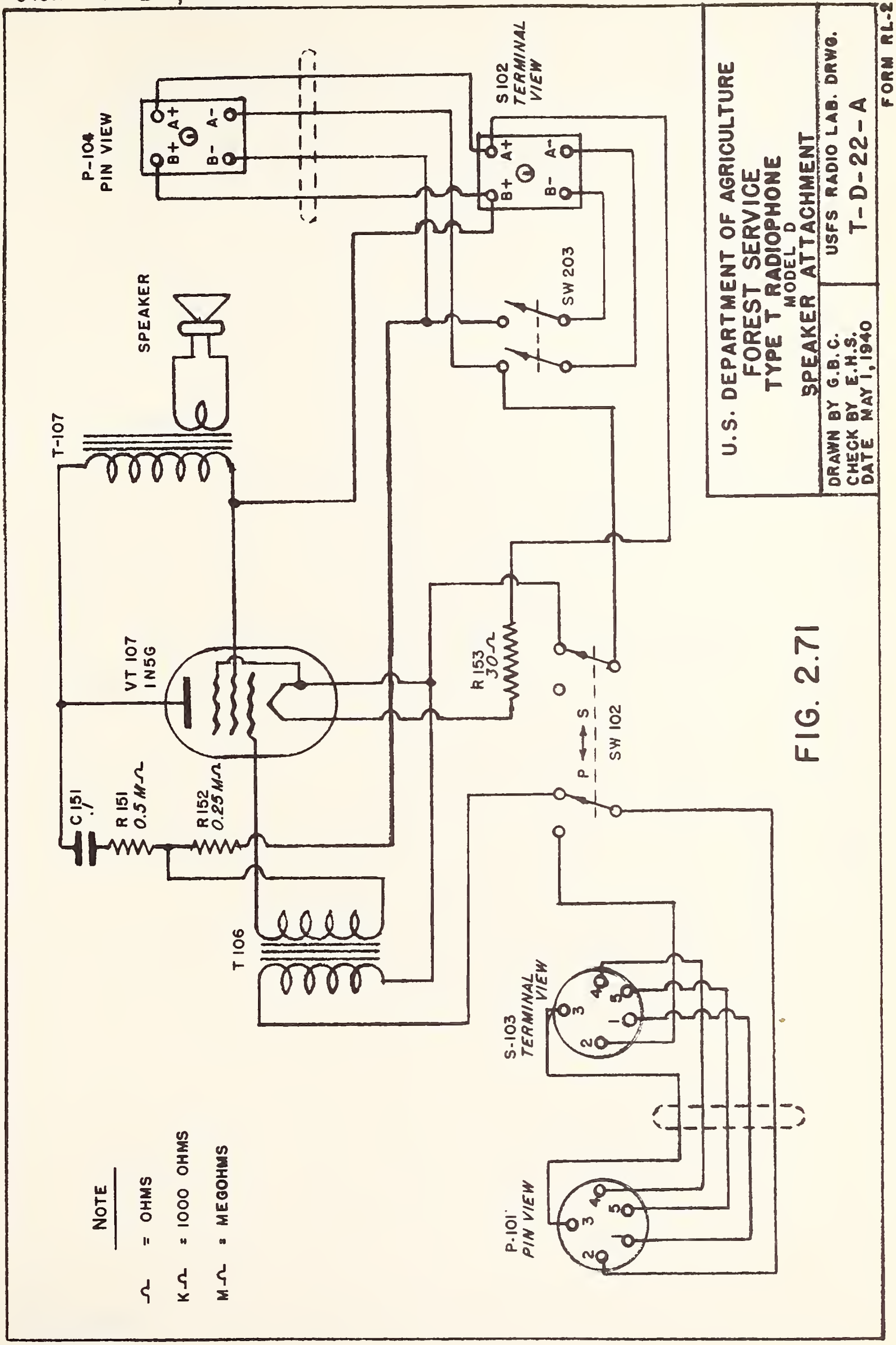


FIG. 2.71

Serial nos. 1 to 5, inclusive

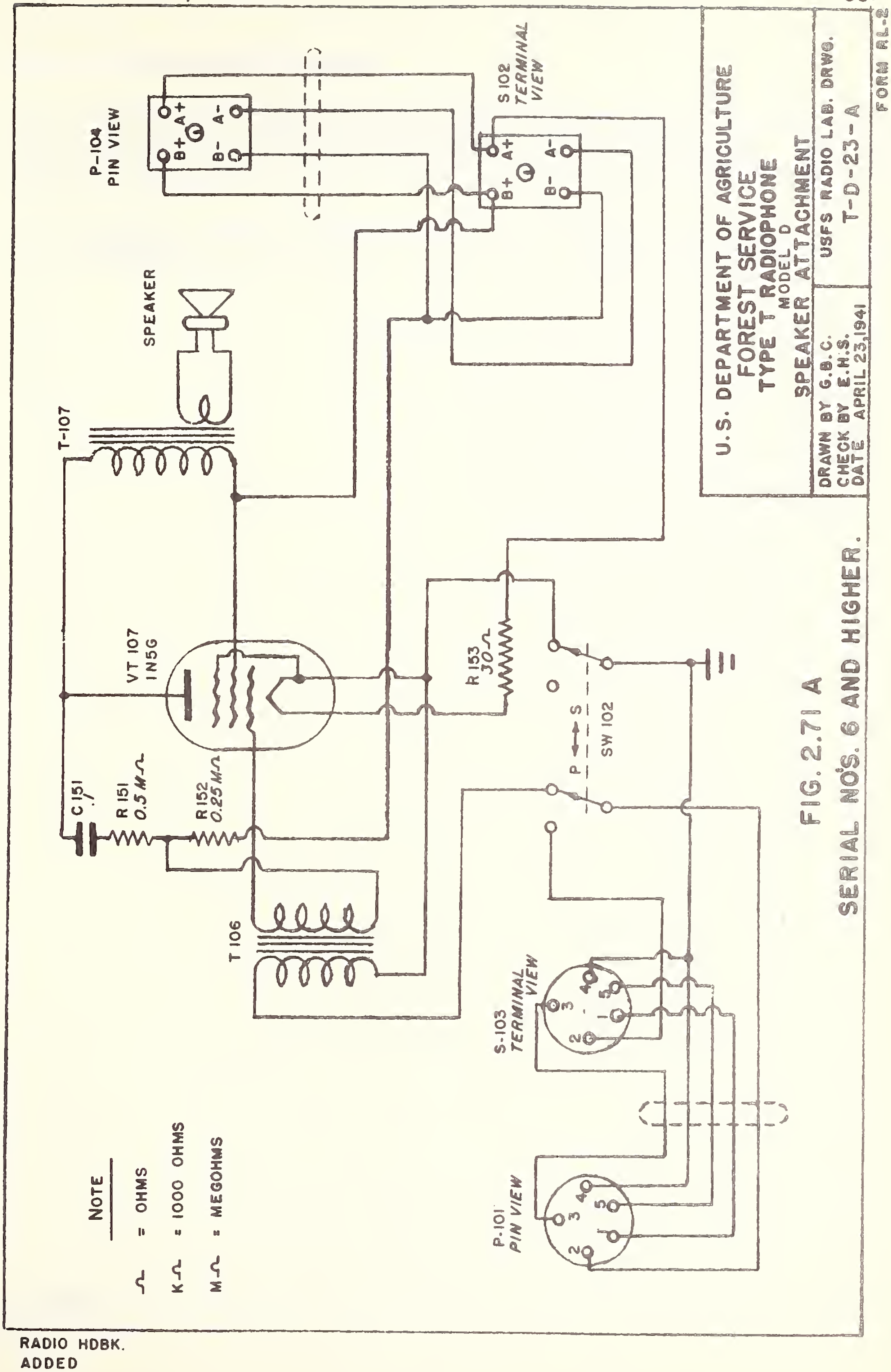


FIG. 2.71 A
SERIAL NO'S. 6 AND HIGHER.

RADIO HDBK.
ADDED
NO. 9

2.72 H-F Oscillator Grid Leak

It has been found that with some converter tubes the h-f oscillator superregenerates instead of oscillating in the normal manner. This tendency can be cured by replacing the 0.2-megohm grid leak R-102 with a 0.1-megohm, 1/2-watt resistor.

Caution. The polystyrene coil form is easily damaged by the heat of the soldering iron.

C13.7 Service Data Sheets

Type T

Models DA and DB

Model DA	Nos.	398	to	411	Inc.
Model DB	Nos.	412	to	___	Inc.

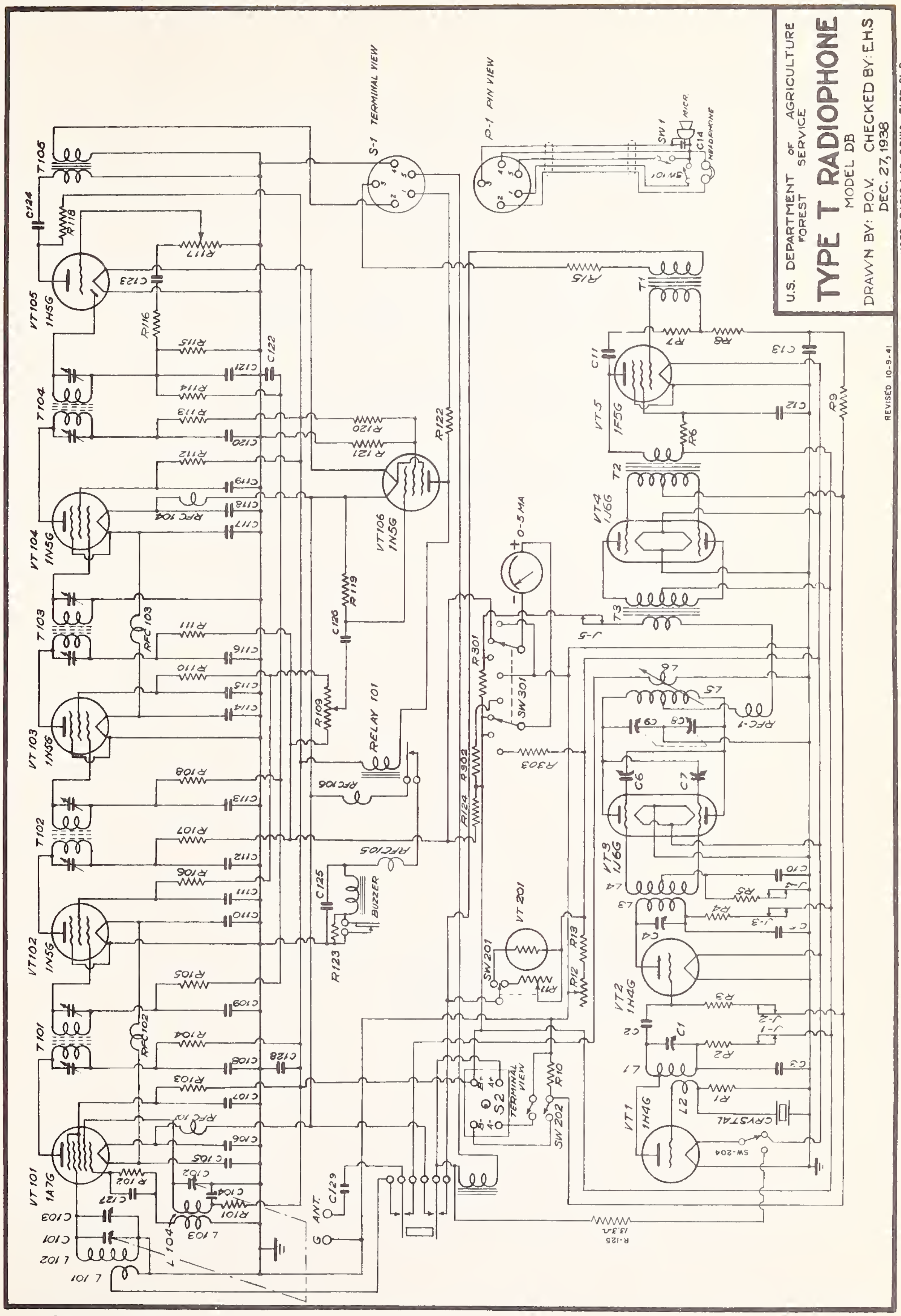
Radio Hdbk.
Added 10-1-41
No. 10

<u>Model DA</u>. The Type T, Model DA, with its associated Type TDA Attachment, was a special-purpose arrangement which had limited distribution. This radiophone is essentially similar to the Type T, Model DB. Schematic diagrams applicable to this equipment are available on request from the Regional Forester, Portland, Oregon.

<u>Model DB.</u> The Type T, Model DB, differs from the Model D in the following details:

1. Provision is made to operate the transmitter crystal oscillator while the receiver is used, to enable the operator to tune the receiver approximately to transmitter frequency.

2. A different style handset is supplied, using a pressed steel case and a different earphone unit.



RADIO HDBK.
ADDED 10-1-41
NO. 10

C13.8 Service Data Sheets

Type I

Model A Nos. 1 to 20 Inc.

Model B See Type K

Model D Nos. 40 to Inc.

Note: For operating information, see "Instructions for Operating", furnished with radio set.

Radio Hbk.
Revised 1-10-40
No. 3

C13.8 Service Data Sheets

Type I

Model B

Nos. 21 to 39 Inc.

The Radiophone formerly known as Type I, Model B (Mobile) is now designated as Type K, Model A. For service information, see Sec. C13.9.

C13.8 Service Data Sheets

Type I

Model D

Nos. 40 to D Inc. INC

Note: For operating information, see "Instructions for Operating", furnished with radio set.

Radio Hbk.
Added 1-10-40
No. 3

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0.2 Physical Specifications

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1.3 Power Supply Circuit

1.4 Switching Circuits

PART 2

2.0 Adjustment and Repair, General

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2.2 Receiver Data

2.3 Power Supply Data

2.5 Parts List

2.6 Diagrams

0.0 General Description

The Type I Radiophone transmits voice or cw telegraph signals over a rated distance of approximately 40 miles in the frequency range 2900 to 3500 kilocycles. The set may be operated on 6 volts d.c. only. The receiver furnished is a sensitive superheterodyne, and covers the same range of frequencies. The transmitter frequency is crystal controlled. A half-wave antenna is used, with a single wire transmission line. Pressing a switch button on the microphone actuates a relay which makes the necessary circuit changes from receive to transmit. When a separate antenna is used on the receiver, the set may be operated duplex ("break-in") fashion.

The Type I Radiophone is housed in a sheet metal cabinet, which has a full-sized carrying handle. The storage battery is similar to an automobile battery and weighs about 40 pounds.

The Type I Radiophone is intended for semi-permanent locations and on large fires, where commercial power is not available, and where there are facilities for battery charging.

0.1 Electrical Specifications

Frequency Range, Transmitter	One specific frequency assigned to Forest Service in range 2900 to 3500 kc
Frequency Control	Crystal
Frequency Range, Receiver	2900 to 3500 kc.
Type of Signal	Voice or cw telegraph
Distance Range	40 to 400 miles
Power Supply	Storage battery
Power Output	10 watts
Antenna	Half-wave, fed off-center
Tube Complement, Transmitter	1 Type 6F6G Oscillator 2 " 6L6G Final Amplifier 1 " 6F6G Speech Amplifier 2 " 6L6G Modulators

Tube Complement, Receiver	1 Type 6S7G r-f Amplifier
	1 " 6D8G Converter
	1 " 6S7G i-f Amplifier
	1 " 6T7G Detector
	1 " 6S7G Beat Oscillator
	1 " 6K6G a-f Amplifier
Input	Hand microphone or telegraph key.
Output	Speaker or headphones

0.2 Physical Specifications

The Type I Radiophone is housed in a sheet metal case, which is provided with a full-sized carrying handle. Overall dimensions of the case are:

Height	$17\frac{1}{2}$ inches
Width	$19\frac{1}{4}$ "
Depth	$12\frac{1}{4}$ "

Approximate dimensions of the storage battery are:

Height	10 inches
Width	10 "
Depth	8 "

Weight of the Type I Radiophone, including microphone, speaker, telegraph key, headphones, and all cables, but excluding storage battery, is 70 pounds. Weight of the storage battery is approximately 40 pounds.

1.0 Detailed Description

The physical arrangement of the components of the Type I Radiophone is shown on the Photodiagram, Fig. 2.63. Parts may be identified by reference to the Parts List (2.5) and the Schematic Diagram (2.62).

The upper chassis of the Radiophone contains the transmitter, complete except for its power supply. The transmitter power supply is a dynamotor, which occupies the left-hand rear portion of the lower section. The receiver and its vibrator power supply are contained on a narrow chassis, which occupies the front portion of the lower section. The speaker is built into the front panel. Microphone, headphones, and key cords plug into receptacles on the front panel. Cables are furnished to provide the necessary connections between receiver, transmitter, and transmitter power supply.

Jacks on the rear of the transmitter chassis facilitate measurement of all plate currents and voltages, and bias voltages.

1.1 Transmitter Circuit

A 6F6G crystal oscillator drives the final amplifier, two parallel 6L6G's. Another pair of push-pull 6L6G's, operating Class AB, modulates the final amplifier. A 6F6G speech amplifier drives the modulator stage.

Referring to Fig. 2.62, the complete Schematic Diagram for the Type I Radiophone, it is seen that the r-f voltage developed by the crystal is applied directly to the grid of VT-1. Grid bias for VT-1 is supplied by the cathode dropping resistor, R1. R1 is grounded either directly, or through a contact in key jack J-1, depending on the position of SW-1. R-f current is excluded from R1 by RFC 2, an r-f choke. C1 bypasses the cathode of VT-1 to ground. The d-c grid circuit for VT-1 is completed by RFC-1. J-2, a shorting type jack on the cathode side of R1, provides convenient access for measurement of oscillator plate current and bias voltage.

The plate circuit of VT-1 consists of L1 in parallel with C2. L1 and C2 are resonated to a frequency close to the crystal frequency. The filter consisting of R2 and C3 keeps r-f currents out of the plate supply.

L2, inductively coupled to L1, excites the grids of VT-2 and VT-3, the final amplifier tubes. R5 and R6 are series grid resistors, which prevent parasitic oscillations. Grid bias for VT-2 and VT-3 is furnished by plate and screen current drop in cathode resistor R4, and by grid current drop in resistor R3. Shorting type jack J-3 provides convenient access for measuring final grid current, and the part of the grid bias due to drop in R3. R3 is bypassed by C5, and the cathodes are bypassed by C16. C4 is the neutralizing capacitor.

Final plate and screen current are supplied through the secondary of the modulation transformer, T3. R7 and RFC-3 are for the purpose of keeping r-f screen and plate currents out of the power supply. C6 bypasses the screens to ground. J-4, a shorting type jack in series with the r-f plate choke RFC-3, provides convenient access for measuring final plate current and voltage.

The plates of the final amplifier are coupled to the r-f plate impedance by C7. The r-f plate impedance consists of a pi-section impedance-matching network, designed to match the antenna impedance to the plate impedance of the tubes. Component parts of this network are L3, C8, C9, and C10. The r-f output from this network connects to a contact on the transmit-receive relay, so that the antenna is connected when the relay is energized.

When the microphone plug is inserted into its receptacle on the front panel, and the transmitter on-off switch SW3 is closed, the microphone is connected in series with the primary of the microphone transformer, T1, a resistor in the power supply, R15, and the 6-volt battery. Sound waves striking the microphone will cause an audio-frequency variation in the resistance of this series circuit, such that the current through the primary of T1 will have an alternating component. An a-f voltage will thus be induced in the secondary of T1. C11 bypasses the battery side of T1 primary to ground. R8 and R9 serve the dual purpose of providing a load for the microphone transformer and a voltage divider for reducing the a-f voltage applied to the grid of VT-4.

Grid bias for VT-4 is supplied by the cathode resistor R10, bypassed by C12. A shorting type jack, J-5, provides convenient access for measurement of plate and screen current, and grid bias voltage.

VT-4 drives the grids of push-pull class AB tubes VT-5 and VT-6 through transformer T2. R11 and R12 are loading resistors for T2. Grid bias for VT-5 and VT-6 is furnished by cathode resistor R13. A shorting type jack, J-6, provides convenient access for measurement of plate and screen current and grid bias. C14 is the cathode bypass capacitor, and C13 is the screen bypass capacitor. Plates of VT-5 and VT-6 connect to the primary of T3, the modulation transformer. The secondary is connected in series with the plates and screens of VT-2 and VT-3, the final amplifier tubes. Thus the a-f voltage developed across the secondary of T3 is superimposed upon the d-c plate voltage to the final amplifier, and plate modulation is thereby made to occur.

A shorting type jack, J-7, provides convenient access for measurement of final plate and screen current.

1.2 Receiver Circuit

The receiver line-up consists of a 6S7G pentode r-f amplifier, a 6D8G converter with self-contained h-f oscillator, a 6S7G i-f amplifier, operating at 465 kc, a 6S7G b-f oscillator, a 6T7G detector-amplifier, and a 6K6G audio output amplifier. The 6T7G detector-amplifier is a duo-diode-triode. One diode plate is used for the detector, while the other furnishes a.v.c. bias when switch SW103 is open. The triode section is an audio amplifier which precedes the output stage. The output stage is used only to operate the speaker. The headphones output comes from the triode section of the 6T7G.

A vibrator power supply is furnished. Its functioning is described in Section 1.3.

Referring to Fig. 2.62, the Schematic Diagram, it is seen that r-f signal currents in L101, the antenna coil, induce a voltage in L102. L102 is tuned by its padder, C101, and a 25 mmf section of the 3-gang variable tuning condenser, C102. The voltage developed in L102 is applied to the grid of VT-101. Part of the fixed grid bias for VT-101 is supplied by cathode resistor R102, bypassed by C104. The total amount of fixed bias on VT-101 and on VT-103, the i-f amplifier, can be controlled by the operator, by manipulation of R101A, the manual r-f gain control. In addition to this fixed bias, an additional bias is applied from the a.v.c. bus when SW103 is open. The a.v.c. bus connects to the ground side of L102 through an isolating resistor, R101, which is bypassed to ground through capacitor C103. Screen voltage for VT-101 is supplied through isolating resistor R103, bypassed by C105.

L103 is the plate coil for VT-101. The lower end of L103 connects to the plate voltage supply through an isolating resistor, R104, which is bypassed to ground by capacitor C106. L104, the grid coil for the converter tube, is inductively coupled to L103. In addition to the inductive coupling, a small amount of capacitive coupling is provided to maintain the energy transfer at the high-frequency end of the band. L104 is tuned by its padder, C107, and a 25 mmf section of the 3-gang variable tuning condenser, C108. Control grid bias for VT-102 is supplied by cathode resistor R106, bypassed by C111. Additional a.v.c. bias is connected to the lower end of L104, through isolating resistor R107A, bypassed to ground through capacitor C109.

The h-f oscillator section of the converter tube, VT-102, has for its tuned grid coil L108, inductively coupled to L109, the anode grid coil. L108 is tuned by its padders, C114 and C115, and by a 50 mmf section of the 3-gang variable tuning condenser, C116. C112 is the h-f oscillator grid condenser, and R107 the grid leak. C113 is the anode grid coil coupling capacitor. D-c anode-grid voltage comes from the plate supply through isolating resistor R108.

The plate coil for VT-102, the converter, is L106, the tuned primary of a 465 kc i-f transformer. Its tuning capacitor, C117, is a mica compression type integral with the transformer. Converter plate voltage is fed to the bottom of L106 through isolating resistor R108A, bypassed to ground through capacitor C119.

Voltage induced in L107, the tuned secondary of the i-f transformer, is applied to the grid of VT-103, the i-f amplifier tube. The tuning capacitor, C118, is integral with the transformer. Grid bias for VT-103 is supplied by cathode resistor R109, bypassed to ground by capacitor C121. Additional a.v.c. bias is connected to the lower end of L107 through isolating resistor R111A, bypassed to ground by C120. Screen voltage comes from the screen bus through isolating resistor R110, bypassed to ground by capacitor C122.

L110, the tuned primary of the 465 kc i-f output transformer, is the plate coil for VT-103. It is tuned by capacitor C124, integral with the transformer. The lower end of L110 connects to the plate supply through isolating resistor R111, bypassed to ground by capacitor C123.

Voltage induced in L111, the tuned secondary of the output i-f transformer, is applied to the diode detector circuit of VT-104. The cathode of VT-104 is grounded to a-f currents through bypass capacitor C127. Current rectified by the detector diode plate passes through R113. This rectified current will have an a-f component corresponding with the modulation envelope on the incoming signal. The a-f component of rectified current, in passing through R113, will give rise to an a-f voltage drop through R113. This a-f voltage is applied to the grid of the triode section of VT-104 through the blocking capacitor C129 and the volume control potentiometer, R116. C126 bypasses the lower end of L111 to ground for i-f currents.

The cathode of VT-104 is raised above ground by plate current flowing through R115, cathode resistor.

In addition to feeding the detector diode plate, L111 feeds the a.v.c. diode plate through blocking capacitor C128. When the signal intensity is sufficient that the instantaneous positive potential on the a.v.c. diode plate exceeds the positive cathode potential, rectification takes place, and d-c current flows. The path for d-c current is from a.v.c. diode plate to cathode, through R115, R112, and R114 back to the diode plate. Thus, when the signal intensity is sufficient, and with SW103 open, a rectified current will flow which will cause a voltage drop across R112. The greater the signal intensity, the higher will be this voltage. This drop is used for a.v.c. voltage for the r-f converter and i-f tubes. Closing SW103 short-circuits R112, thereby removing the a.v.c. feature from the receiver.

VT-105, the b-f oscillator, is one of the electron coupled type with grounded oscillator anode-grid. The oscillator coil, L105, is tuned by C132, a mica compression capacitor in the same shield can as L105. C136 is the grid condenser, and R119 the grid leak. The screen, which is the oscillator anode grid, is bypassed to ground by capacitor C133. Plate voltage for VT-105 comes from the power supply through dropping resistor R120. Screen voltage is taken from the plate through a voltage divider consisting of R121 and R122 in series. The oscillator output is taken from the plate of VT-105, and injected into the detector diode lead by capacitive coupling. This coupling capacitor consists of a piece of insulated hook-up wire from the plate of VT-105 being wrapped around the lead to the detector diode plate. The b-f oscillator on-off

switch, SW102, is a DPST switch. In the "on" position it connects plate voltage to VT-105, and short-circuits R112, thereby shutting off a.v.c. when code signals are being received.

The output of the triode section of VT-105 is resistance coupled to the headphones jack, J-101. R117 is the plate coupling resistor, and plate voltage is fed to the lower end of R117 through filter resistor R118, which is bypassed to ground by capacitor C130. J-101 is a double circuit jack, and when the headphones plug is removed, R123 is substituted for the headphones load. Voltage across R123 is coupled to the grid of VT-106, power output tube, through capacitor C134. Grid bias is supplied by cathode resistor R125, bypassed by C135. The d-c grid circuit is completed by resistor R124.

The output of VT-106 goes to the primary of the speaker transformer, mounted on the speaker, through one of the cables and jack J-8. Screen and plate voltage for VT-106 come from the plate bus.

SW101, the receiver on-off switch, turns on the filaments. The low-voltage supply to the vibrator goes through SW101 and also through contacts on the transmit-receive relay. In order for the vibrator to work, it is necessary that the transmit-receive relay be unenergized.

1.3 Power Supply Circuit

(a) Transmitter

Vacuum tube heater voltage and microphone battery voltage are taken directly from the storage battery. Plate and screen voltages are taken from the battery operated dynamotor, which has a rated output of 0.200 ampere at 250 volts. Plate and screen voltages are lowered, where necessary, by means of a series dropping resistor. All grid bias voltages are supplied by means of cathode dropping resistors. In the case of the final amplifier, additional bias is supplied by grid current drop in a grid resistor.

Referring to Fig. 2.62, it is seen that negative battery is grounded and positive battery is bypassed by C15. The two battery leads connect to the terminals of S5, receptacle for the receiver power plug. SW3 is the transmitter on-off switch. When SW3 is closed, voltage is applied to vacuum tube heaters through contacts 1 and 2 in S2 and P2. When it is desired to transmit, the transmit-receive relay must be energized, by closing either SW2, the microphone switch, or SW4. Current flows from positive battery through SW3, through current limiting resistor R16, through contacts 4 of S2 and P2, through the relay coil, then through either SW2 or SW4 to ground, which is connected to negative battery.

When the transmit-receive relay is energized, the dynamotor relay is also energized. Current flows from the positive battery terminal through the coil of the dynamotor relay, through contacts 7 on S2 and P2, through the contacts on the transmit-receive relay, back through contacts 8 on S2 and P2, to ground in the power supply unit. When the dynamotor relay is energized, the dynamotor primary circuit is completed and the dynamotor comes up to speed quickly.

Voltage from the secondary of the dynamotor is bypassed for commutator ripple and for r-f noise by capacitors C17, C18, and C19. Plate voltage for VT-1, VT-2, VT-3, VT-5, and VT-6, and screen voltage for VT-2 and VT-3 are taken directly from the filtered output of the dynamotor, through contacts 6 in S2 and P2. Plate voltage for VT-4 and screen voltage for VT-4, VT-5, and VT-6 are supplied through dropping resistor R14 and contacts 5 of S2 and P2.

When the transmit-receive relay is de-energized, relay contacts connect R17, a dynamic-braking resistor, across the high-voltage terminals of the dynamotor. R17 causes the dynamotor to stop quickly, thereby shortening the period during which the coasting dynamotor produces commutator noises in the receiver. Fuse 1 is a short length of low-melting point alloy wire, wound around R17 and connected in series with it. If the dynamotor primary relay should stick closed, the heat produced in R17 will melt the fuse and prevent damage to the dynamotor.

Microphone battery voltage is supplied through SW3, current-limiting resistor R15, contacts 3 of S2 and P2, through the primary of T1, through the microphone to ground.

Grid bias voltages are discussed in detail in Section 1.1, Transmitter Circuit.

Battery drains for transmitter operation are as follows:

Transmitter Connections	Battery Drain
Vacuum Tube Heaters Only	5.5 Amperes
Transmitter Operating	18.0 Amperes

(b) Receiver

Vacuum tube heater voltage is taken directly from the storage battery. Plate and screen voltages are taken from the battery operated vibrator power supply. Plate and screen voltages are lowered where necessary by series dropping resistors and by bleeder resistors. Grid bias voltages are supplied by cathode dropping resistors. In the case of the h-f and b-f oscillator circuits, grid bias is supplied by

grid leaks. Additional variable bias for a.v.c. is also available under some conditions, as described above in Section 1.2, Receiver Circuit.

Battery voltage is brought into the receiver from the battery terminals, through the contacts of S5 and P5, through the receiver cable, through contacts in P4 to contacts in S4. Closing SW101, the on-off switch, applies battery voltage to the vacuum tube heaters. SW101 is in the positive battery lead.

When SW101 is closed and the transmit-receive relay is de-energized, battery voltage is applied to the vibrator. Current flows through SW101, through contacts in S4 and P4, through the cable, through contacts in P3 and S3, through contacts in the transmit-receive relay, back through contacts in S3 and P3, through the cable, through contacts in P4 and S4, through the vibrator input circuit, to ground.

Within the vibrator unit, L201 and C201 comprise a filter which prevents r-f noise generated in the vibrator contacts from getting back into the heater leads. T201 is the vibrator power transformer. C202 and R201 are components necessary for the proper functioning of the vibrator. L202 and C204 comprise a filter which prevents r-f noise generated in the vibrator contacts from getting into the plate supply leads. L203, C205, and C206 are reactors for filtering the low vibrator frequency ripple from the plate supply.

The output of the power supply is connected directly to the plate voltage bus. Voltage for the screen bus is reduced by means of the bleeder consisting of R103A, R102A, and R101A. R101A, the r-f gain control, is a potentiometer, the slider of which goes to the cathode return circuits of VT-101 and VT-103. Manipulation of R101A varies the grid bias of these two tubes over a limited range, thereby providing the operator with manual gain control.

Battery drains for receiver operation are as follows:

Receiver Connection	Battery Drain
Vacuum Tube Heaters Only	1.2 Amperes
Receiver Operating	3.5 Amperes

1.4 Switching Circuits

(a) Transmitter

For transmitter voice operation, the battery and all cables must be properly connected, and key jack J-1 must be vacant. Closing the

on-off switch, SW3, lights all vacuum tube heaters, and makes it possible to start the dynamotor by closing either the microphone switch, SW2, or SW4. Detailed operation of these switching circuits is described above, in Section 1.3, Power Supply Circuits.

When the transmit-receive relay is energized by closing SW2 or SW4, the following functions are performed:

(1) Dynamotor relay is energized.

(2) Receiver vibrator power supply is disconnected.

(3) Antenna is connected to transmitter.

For transmitter cw telegraph operation, the key-cord plug is inserted into key jack J-1. Contacts on J-1 short circuit the primary of the microphone transformer, thereby rendering the speech amplifier and modulator ineffective. When the key is up, the cathode return circuit for the final amplifier is open, and the transmitter does not function.

Normally SW1 is switched to the "RECV. AND VOICE TRANS." position, such that VT-1, the oscillator tube, operates continuously, and only the operation of the final amplifier is keyed. SW1 is switched to the "TRANS. C.W." position only when break-in operation is desired. In this connection, both the oscillator and the final amplifier are keyed. In some models of the Type I, SW1 contains an additional pole which, when SW1 is in "TRANS. C.W." position, supplies battery power to the receiver vibrator continuously during cw break-in operation, regardless of whether the transmit-receive relay is energized. Field experience has shown that cw break-in operation is seldom advantageous.

(b) Receiver

Closing the on-off switch, SW101, lights all vacuum tube heaters, and makes it possible to start the vibrator power supply by de-energizing the transmit-receive relay. Detailed operation of these switching circuits is described above in Section 1.3, Power Supply Circuits.

When the transmit-receive relay is de-energized, the following functions are performed:

(1) Dynamotor relay is de-energized.

(2) Dynamic breaking resistor, R17, is connected in series with fuse across dynamotor output to stop dynamotor quickly.

(3) Battery voltage is supplied to vibrator power supply.

(4) Antenna is switched to receiver.

The b-f oscillator on-off switch, SW102, is a DPST switch. One pole switches plate and screen voltage to VT-105, while the other grounds the a.v.c. bus for telegraph operation.

The a.v.c. on-off switch, SW103, grounds the a.v.c. bus when a.v.c. is not desired.

J-101 is a double circuit jack, which disconnects the input to VT-106, the audio power amplifier, when the headset plug is in J-101.

2.0 Adjustment and Repair, General

The following tools and equipment are needed for repair and adjustment of the Type I Radiophone:

(1) Usual complement of bench and hand tools.

(2) Tube checker.

(3) High resistance voltmeter, 1000 or more ohms per volt. Scales needed: 0-10, 0-250, 0-1000 volts.

(4) Ohmmeter.

(5) Cathode-ray oscilloscope.

(6) Signal generator, with range 2900 to 3500 kc, and also 465 kc.

(7) Tuning wand, such as Aladdin Resonator.

(8) Audio power output meter. If item (3) has a-c voltmeter scales, the 0-10 volt a-c range may be used in place of item (8).

(9) D-c milliammeter, with ranges 0-10, 0-50, and 0-250 milliamperes.

If the transmitter or receiver or both fail to function, the following procedure should be used in locating the trouble:

(1) See that storage battery is well charged. A hydrometer will indicate a specific gravity of 1.280 for a fully charged battery, 1.250 for half charge, and 1.220 for a discharged battery. See that battery clips are making good contact.

(2) Remove rear cover plate. See that all cable connections are firmly engaged and making good contact. See that prongs on cable plugs are clean.

2.1 Transmitter Data

(1) If the transmitter still fails to operate, first note whether the dynamotor comes to full speed and to a stop quickly when SW4 is turned on and off, with SW3 previously turned on.

(2) If it does, next test transmitter tubes. They should be removed from their sockets carefully, taking precaution not to strike them against the top of the cabinet when they leave their sockets. If one of the 6F6G's tests better than the other, and there is no normal spare available, the better tube should be used as VT-1. Similarly, if any of the 6L6G's test slightly low, the better ones should be used as VT-3 and VT-4. In an emergency, equivalent types of metal tubes may be substituted throughout the transmitter but where possible this should be avoided, especially in the r-f section. In replacing the tubes in their sockets, make certain that the indexing pin is in its proper position before pushing in the tube. If the tube is forced in with pins in the wrong position, both tube and socket may be damaged.

(3) If the above steps do not clear the trouble, remove the transmitter from the cabinet. Remove the 3 large screws from each side of the case, pull out meter and speaker plugs, disengage transmitter cables, disconnect lead to antenna post, and carefully slide out the transmitter chassis.

(4) Remove cover of transmit-receive relay. Inspect springs and contacts and see that clean, firm connections are made. Replace the cables in their receptacles, and see that the relay operates when SW2 or SW4 is closed. See that the relay armature is free to move against its spring and is not binding. If relay does not operate, trace the circuit of its coil by use of Fig. 2.62 and a d-c voltmeter.

(5) If transmit-receive relay operates, but dynamotor will not start, see instructions in 2.3, Power Supply Data.

(6) Check voltages and currents at all measuring jacks. The following approximate values will serve as a guide.

Measurement	Jack Symbol	Jack Label	Meter Connection	Value
Final plate & screen volts	J-4	Meter	+ prod to either jack - prod to chassis	250 volts

Measurement	Jack Symbol	Jack Label	Meter Connection	Value
Modulator plate volts	J-7	Final Pl. and Scr.	+ prod to either jack - prod to chassis	250 volts
Speech Amp. plate & screen & mod. screen volts	---	---	+ prod to #3 pin on VT-4 socket - prod to chassis	195 "
Oscillator plate current	J-2	Osc. plate	+ prod in top jack - prod in bottom jack	12.5 ma.
Final plate current	J-4	Meter	+ prod in + jack - prod in - jack	63 ma.
Final plate and screen current	J-7	Final Pl. and Scr.	+ prod in top jack - prod in bottom jack	67 ma.
Speech amp. plate & screen current	J-5	S.A. Pl. and Scr.	Ditto	23 ma.
Mod. Pl. and Scr. current	J-6	Mod. Pl.	Ditto	63 to 110 ma. (varies with modulation)
Final grid current	J-3	Final grid	- prod in bottom jack + prod in top jack	1.7 ma.
Oscillator bias volts	J-2	Osc. Plate	+ prod to either jack - prod to chassis	6 volts
Speech Amp. bias volts	J-5	S.A. Pl. and Scr.	+ prod to either jack - prod to chassis	12 volts
Modulator bias volts	J-6	Mod. Pl. and Scr.	Ditto	13.5 volts

Caution: When measuring current according to the above instructions, when one prod has been inserted into a jack, do not permit the other prod to touch the chassis, or damage to the milliammeter will result.

(7) If the above steps do not reveal the trouble, inspect transmitter carefully for loose, broken, or unsoldered connections. See that no components have been moved from their original positions or damaged. While the chassis is out of the cabinet, work the tubes in and out of their sockets a few times.

(8) Measure transformer resistances. See that the measurements correspond with the resistances stated on Fig. 2.63, the Photodiagram.

(9) By means of Fig. 2.62, the Schematic Diagram, and Fig. 2.63, the Photodiagram, and 2.5, the Parts List, check the wiring and trace the circuit. Repair trouble as disclosed.

Transmitter Adjustment

The transmitter should be retuned only if actually in need of adjustment, and only by a competent technician.

(1) Remove transmitter chassis from cabinet. Plug key into key jack J-1 and see that switch SW1 is in "NORMAL" position. Leave key open, as it is desired to keep final amplifier from operating.

(2) Connect cables to transmitter and battery. Turn SW3 on. After a 30-seconds' delay, turn SW4 on. Insert 0-50 ma. milliammeter prods in J-2, positive prod on top. Turn C2 to maximum capacitance (plates completely meshed). Slowly unmesh plates until milliammeter increases sharply. Continue to unmesh plates until milliammeter reading increases to 12.5 ma. Remove milliammeter prods.

(3) The next step is the neutralization of the final stage. The telegraph key is left open, so that plate current does not flow in the final stage. Using the rectifier-wavemeter connection, resonate the USFS Type A Test Meter to transmitter frequency by coupling its coil to oscillator coil L1, and adjusting dial for maximum Test Meter deflection. Coupling should not be closer than necessary to produce a meter indication.

With Test Meter tuning undisturbed, couple Test Meter coil to final tank coil, L3. Resonate final tank circuit by varying C8. Resonance will be indicated by maximum current in Type A Test Meter. Coupling between L3 and Test Meter coil should be adjusted so that this maximum current is somewhat above mid-scale.

Vary C4 for minimum or zero Test Meter current.

An alternate method of neutralizing, making use of the oscilloscope, is stated in paragraph 4.

(4) To neutralize by means of the oscilloscope, leave telegraph key open and couple oscilloscope pick-up coil to L3. Vary C8 for maximum aplitude of oscilloscope pattern. Then vary C4, the neutralizing capacitor, seeking a setting that reduces the amplitude of the oscilloscope pattern to a minimum. If oscilloscope and USFS Type A Test Meter are not available, check neutralizing by observing coincidence of maximum grid current with minimum plate current in the final stage. Transmitter must have all voltage applied for this latter check.

(5) Open switch SW4 and remove key plug from J-1. Connect antenna to antenna lead. Insert prods of 0-250 ma. milliammeter into J-4. Close SW4 and tune C8 for minimum meter reading. If minimum meter reading is more than 65 ma., increase C9 capacitance and retune C8 for minimum meter reading. Repeat this process until minimum meter reading is between 60 and 65 ma. If initial minimum meter reading is less than 60 ma., follow the same procedure, except that capacitance of C9 is decreased for the successive trials. Check modulation by inspecting pattern on oscilloscope while talking or whistling into microphone.

(6) Replace transmitter chassis in cabinet.

2.2 Receiver Data

DATA

(1) If, after checking condition of storage battery and cable terminals, the receiver still fails to operate, see that speaker terminals are in their jacks firmly, and that proper cable lead connects to receiver antenna post.

(2) Check tubes. If the transmitter chassis is out of the cabinet, tubes can be removed without taking receiver out of cabinet. To remove receiver from cabinet, pull speaker and meter terminals out of their jacks on the transmitter chassis, disconnect lead to panel antenna post, and remove mounting screws from "TRANS. FIL." switch. Remove the screws which hold the front panel to the cabinet. Remove front panel to which receiver is attached.

After checking tubes, work them in and out of their sockets a few times to brighten the socket connections.

(3) Inspect receiver for loose, broken, or unsoldered connections. See that parts have not become damaged or moved from their original positions.

(4) Measure voltages on plate and screen buses. For measuring plate bus voltage, plate voltmeter prods on (a) #3 terminal of VT-101 socket and (b) chassis. For measuring screen voltage, place voltmeter prods on (a) #4 terminal of VT-101 socket and (b) chassis. Plate bus should show 250 volts, and screen bus 220 volts. If voltages differ from above values by more than 10%, trouble is likely to be in power supply and should be located and repaired as outlined in Section 2.3, Power Supply Data. Ruptured receiver bypass condensers are also possible causes of low bus voltage.

(5) Make a systematic check of the receiver using Fig. 2.62, the Schematic Diagram, Fig. 2.63, the Photodiagram, and 2.5, the Parts List.

Receiver Alignment

Alignment of the Type I Receiver should be undertaken only if actually needed and only by a competent technician.

(1) With receiver out of cabinet, connect cables to transmitter, receiver, and battery. Connect power output meter to speaker jacks and set resistance of meter at 8000 ohms. If 0-10 volts a-c meter is to be used for output meter, plug speaker leads into speaker jack, and connect voltmeter terminals to speaker transformer primary. A 1 mf blocking condenser should be connected in series with the meter.

(2) Connect output of signal generator to grid cap of converter tube, VT-102, through a .001 mica capacitor. Connect the grid clip in the receiver to the grid cap of the tube through a 1-megohm 1/2-watt resistor. Connect signal generator ground to receiver chassis. Set signal generator frequency at 465 kc, and turn receiver on. Increase signal generator output until meter deflects to about mid-scale. Vary i-f transformer turning capacitors C117, C118, C124, and C125 for maximum needle deflection. If needle goes off scale, lower the input from signal generator.

(3) Remove signal generator lead from VT-102, replace grid cap and shield. Connect signal generator output to antenna post through 400-ohm non-inductive resistor. Plug headphones into J-101, set signal generator frequency at 3500 kc, and tune signal in on headset with tuning dial. The signal should come in at about 90 on the dial. If the dial reading differs very much from 90, set the dial at 90 and tune the signal in by varying C115, the h-f oscillator tuning padder.

(4) Remove headset plug from J-101, and adjust signal generator output so that output meter deflects about half-scale. Return receiver for maximum deflection, reducing input from signal generator as required to keep output meter on scale. Adjust C101, antenna coil padder capacitor, for maximum output meter deflection. Rock the tuning capacitor

back and forth across resonance while making this adjustment. Adjust C107, r-f coil padder capacitor, in the same manner.

(5) Set signal generator frequency at 2900 kc. Plug headset in J-101 and tune signal in with tuning dial. Signal should come in at about 20 on the dial. Set the receiver on its side, and remove headset plug from J-101. Insert each end of the tuning wand into L101, L102, while watching the output meter. If the output meter shows a marked upward deflection when the brass plug end of the wand is inserted, then capacitance of C102 is too high. If meter shows marked upward deflection when powdered-iron end is inserted, capacitance is too low. To change capacitance, unmesh the tuning capacitor, and bend the end rotor plate of C102 slightly in the proper direction. To decrease capacitance, bend plate so as to increase spacing between rotor and stator plates. Check frequently with tuning wand while making this adjustment to ascertain that change is taking place in proper direction. Be sure that rotor and stator plates do not touch, in any position of the tuning dial.

(6) Repeat the above procedure, inserting tuning wand into L103, L104, making adjustment only if required on tuning capacitor C108.

(7) With receiver tuned for maximum output meter deflection re-adjust i-f transformer capacitors C117, C118, C124, and C125 for maximum meter deflection.

(8) With receiver tuned for maximum output meter deflection, plug headset into J-101. Switch modulation off signal generator. Switch b-f oscillator on by closing SW102. An audible beat note should be heard in the headset. The pitch of this note may be adjusted by varying C132, integral with L105. With the receiver tuning unchanged, lower the pitch until a condition of zero beat is obtained.

(9) Disconnect signal generator and output meter, and install receiver back in cabinet.

2.3 Power Supply Data

Transmitter

If inspection shows the transmit-receive relay operates and is in good shape, but dynamotor will not start, determine if dynamotor relay is being energized. Determine if relay is making good contact. Relay terminals are identified with stampings "B," "H," and "S," corresponding with terminal identifications on Fig. 2.62. If relay contacts stick, remove cover and dress contacts with a fine magneto file. See that after such dressing the contacts come together over their entire surfaces.

If the dynamotor relay is in good order, but the dynamotor does not operate, connect relay terminals "B" and "H" with a short wire. If dynamotor still does not operate, check its leads. Failure of the dynamotor itself is rare. If it is determined that the trouble is actually in the dynamotor, remove it, base and all, from the cabinet. Remove dust covers, and inspect brushes and commutator. Replace brushes if they are badly worn. If the commutator is dirty or pitted, clean it with fine (#00) sandpaper, never emery. Once per year the ball bearings should be lubricated with a small amount of vaseline, applied through the plug at the center of the end spider. In re-assembling, ascertain that dust covers fit snugly and that all screws are tight.

If the dynamotor rotates satisfactorily, but does not deliver output voltage, test capacitors C17, C18, and C19 for short circuits. The positive side of each capacitor must be disconnected from the dynamotor lead for this measurement. If these capacitors are found unshorted, yet no output voltage is delivered, service the brushes and commutator on the secondary end of the dynamotor as outlined for the primary end.

Receiver

(1) In case of failure of power supply, ascertain that 6-volt power is being delivered to vibrator. This test can be made by measuring 6 volts d-c across C203. Also, when the vibrator is operating, a barely audible hum can be heard by putting the ear close to the power supply case.

(2) Test filter capacitors C205 and C206 for short circuits. Positive sides of these capacitors must be disconnected from circuit for this test.

(3) Disconnect leads from filter choke, L203, and test for grounded winding.

(4) If a spare vibrator is at hand, replace the one in the power supply and see if the trouble clears.

(5) Check power transformer for open and short circuits and grounds.

(6) Check all other circuit components by use of Fig. 2.62, the Schematic Diagram, and 2.5, the Parts List.

(7) If no spare vibrator was on hand for the test of Paragraph (4), and all of the other items in this section have failed to locate the trouble, order a new vibrator and replace.

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Oscillator cathode bypass	.0001 mf mica	(Aerovox (Solar	1468) or MO-1416) equiv.
C2	Oscillator plate tuning	50 mmf variable	Cardwell	ZR-50-AS
C3	Oscillator plate bypass	.001 mf mica	(Aerovox (Solar	1467) " MW-1127)
C4	Final neutralizing	4 mmf variable	Cardwell	Zs-4-SS
C5	Final grid-return bypass	.002 mf mica	(Aerovox (Solar	1467) " NW-1233)
C6	Final screen bypass	.002 mf 2500-v	(Cornell- (Dubilier (Aerovox	9-52020) ") 1652)
C7	Final plate blocking	.002 mf 2500-v	(Cornell- (Dubilier (Aerovox	9-52020) ") 1652)
C8	Final resonating	365 mmf variable	Cardwell	MR-365-BS
C9	Final loading	365 mmf variable	Cardwell	MR-365-BS
C10	Final loading padding	250 mmf 2500-v	(Cornell- (Dubilier (Aerovox	9-53025)) 1652)
C11	Microphone battery bypass (in same case with C12)	10 mf 50-v)	Mallory	BN-226
C12	Audio amplifier cathode bypass (in same case with C11)	10 mf 50-v)	Mallory	BN-226
C13	Modulator screen bypass	8 mf 500-v	Mallory	HD-683
C14	Modulator cathode bypass	10 mf 50-v	Mallory	BN-226
C15	Dynamotor filter (in same unit with C17)	.5 mf 400-v	Cornell- Dubilier	DB 4050

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C16	Final cathode bypass	.002 mf mica	(Aerovox (Solar	1467) or MW-1233)equiv.
C17	Dynamotor filter (in same unit with C15)	.5 mf 400-v	(See C15)	
C18) C19)	Dynamotor filter	4 - 8 mf 450-v	Mallory	CN-151
C101	Antenna trimming	50 mmf variable	Hammarlund	APC-50
C102) C108) C116)	" r-f and h-f oscillator tuning	Special 3-gang 25-50-25 mmf variable	Hammarlund	No type No. APC-type construction
C103	R-f grid-return bypass	.01 mf 600-v	Solar	MP-4135
C104	R-f cathode bypass	.1 mf 400-v	Solar	MP-4147
C105	R-f screen bypass	.02 mf 600-v	Solar	MP-4137
C106	R-f plate bypass	.002 mf mica	(Aerovox (Solar	1467) or MW-1233)equiv.
C107	R-f trimmer	50 mmf variable	Hammarlund	APC-50
C109	Converter grid-return bypass	.01 mf 600-v	Solar	MP-4135
C110	Converter screen bypass	.02 mf 600-v	Solar	MP-4137
C111	Converter cathode bypass	.1 mf 400-v	Solar	MP-4147
C112	H-f oscillator grid	50 mmf mica	(Solar (Aerovox	MT-1310) or 1465)equiv.
C113	H-f oscillator anode grid blocking	.001 mf mica	(Solar (Aerovox	MW-1227) " 1467)
C114	H-f oscillator tank padding	40 mmf mica	(Solar (Aerovox	MO-1408) " 1468)
C115	H-f oscillator tank trimmer	50 mmf variable	Hammarlund	APC-50
C117	I-f transformer tuning		Integral with L106-L107	

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C118	I-f transformer tuning		Integral with L106-L107	
C119	Converter plate bypass	.02 mf 600-v	Solar	MP-4137
C120	I-f grid-return bypass	.01 mf 600-v	Solar	MP-4135
C121	I-f cathode bypass	.1 mf 400-v	Solar	MP-4147
C122	I-f screen bypass	.02 mf 600-v	Solar	MP-4137
C123	I-f plate bypass	.02 mf 600-v	Solar	MP-4137
C124	I-f transformer tuning		Integral with L110-L111	
C125	I-f transformer tuning		" " " "	
C126	Diode return bypass	250 mmf mica	(Solar (Aerovox	MO-1419) or 1468) equiv.
C127	Detector cathode bypass (in same case with C135)	10 mf 50-v	Mallory	BN-226
C128	AVC diode plate coupling	250 mmf mica	(Solar (Aerovox	MO-1419) " 1468)
C129	Volume control blocking	.01 mf 600-v	Solar	MP-4135
C130	Detector plate bypass	.25 mf 200-v	Solar	P-1502
C131	Audio amp. blocking	.1 mf 400-v	Solar	MP-4147
C132	B-f oscillator tuning		Integral with L105	
C133	Audio amp. screen bypass	.01 mf 600-v	Solar	MP-4135
C134	Audio amp. coupling	.01 mf 600-v	Solar	MP-4135
C135	Audio amp. cathode (in same case with C127)	10 mf 50-v	See C127	
C136	B-f oscillator grid		Integral with L105	
C201	Vibrator filter	.1 mf 400-v	Solar	MP-4147

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C202	Vibrator filter	.0075 mf 1600-v	Mallory	VB-470
C203	Vibrator filter	.5 mf 50-v	Mallory	RF-481
C204	Vibrator filter	.05 mf 600	Solar	S-0244
C205	Vibrator filter (in same can with C206)	8 mf 450-v	Mallory	RM-262
C206	Vibrator filter (in same unit with C205)	8 mf 450-v	See C205	

2.52 Inductors

SYMBOL	COMPONENT	NUMBER OF TURNS	WIRE	FORM	MANUFACTURER	TYPE
L1	Oscillator plate	50	#26 AWG enamel		National	XR-2
L2	Final grid	39	#26 AWG enamel	3/4" dia. mounted inside L1		
L3	Final plate	25	#16 AWG enamel		National	XR-4

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L101) L102)	Antenna coil		Miller	Style 5853, Type 32-618
L103) L104)	Detector coil		Miller	Style 5853, Type 32-620
L105	B-f oscillator coil		Aladdin	C-350
L106) L107)	I-f transformer	465 kc	Aladdin	C-101M
L108) L109)	H-f oscillator coil		Miller	Style 5853, Type 32-619
L110) L111)	I-f transformer	465 kc	Aladdin	C-200M

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L201	Vibrator filter	32 turns #16 AWG enamel wire, self-supporting, wound on $\frac{1}{2}$" form		
L202	R-f choke	2.1 mh., 125 ma.	Hammarlund	CH-X
L203	Filter reactor	14.5 h, 35 ma.	Halldorson	T-391
RFC-1	Oscillator grid	2.1 mh., 125 ma.	Hammarlund	CH-X
RFC-2	Oscillator cathode	2.1 mh., 125 ma.	Hammarlund	CH-X
RFC-3	Final plate	2.1 mh., 125 ma.	Hammarlund	CH-X

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R1	Oscillator cathode dropping	500 ohms, 1 watt	I.R.C.	BT-1
R2	Oscillator plate filter	500 ohms, 1 watt	I.R.C.	BT-1
R3	Final grid filter	20000 ohms, 1 watt	I.R.C.	BT-1 .
R4	Final cathod dropping	250 ohms, 10 watts	Ohmite	Brown Devil
R5	Final grid series	50 ohms, 1 watt	I.R.C.	BT-1
R6	Final grid series	50 ohms, 1 watt	I.R.C.	BT-1
R7	Final screen dropping	7500 ohms, 10 watts	Ohmite	Brown Devil
R8	Voltage divider	0.25 meg. $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R9	Voltage divider	25000 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R10	Audio amp. cathode	500 ohms, 1 watt	I.R.C.	BT-1
R11	Transformer loading	5000 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R12	Transformer loading	5000 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R13	Modulator cathode	200 ohms, 10 watts	Ohmite	Brown-Devil
R14	Voltage dropping	2000 ohms, 10 watts	Ohmite	Brown-Devil
R15	Voltage dropping	100 ohms, 1 watt	I.R.C.	BT-1
R16	Voltage dropping	3 ohms, 10 watts	Ohmite	Brown-Devil
R17*	Dynamotor braking load	50 ohms, 10 watts	Ohmite	Brown-Devil
R101	R-f grid filter	0.25 meg. $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R101A	R-f gain control	5000 ohm potentiometer	(I.R.C. (Mallory	11-114) A5MP)
R102	R-f cathode	400 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R102A	Grid bias voltage divider	20000 ohms, 1 watt	I.R.C.	BT-1
R103	R-f screen filter	1250 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R103A	Screen dropping	7500 ohms, 2 watts	I.R.C.	BT-2
R104	R-f plate filter	1250 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R105	Converter screen filter	1500 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R106	Converter cathode	300 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R107	H-f oscillator grid leak	50000 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R107A	Converter grid filter	0.25 meg. $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R108	H-f oscillator anode grid	25000 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R108A	Converter plate filter	1500 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$

*R17 is connected in series with Fuse-1. Fuse-1 is a 2-inch length of thin fuse or solder wire, dia. about 0.050 in., wrapped around R-17.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R109	I-f cathode	400 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R110	I-f screen filter	1250 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R111	I-f plate filter	1250 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R111A	I-f grid filter	0.25 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R112	AVC diode load	1 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R113	Detector diode load	0.5 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R114	AVC diode resistor	0.5 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R115	Detector cathode	3000 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R116	Volume control	0.5 meg.potentiometer	(I.R.C. (Mallory	13-133 N
R117	Detector plate	0.1 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R118	Detector plate filter	50000 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R119	B-f oscillator grid leak		Integral with L-105	
R120	B-f oscillator plate	.25 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R121	B-f oscillator screen	0.1 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R122	B-f oscillator screen	0.1 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R123	Audio coupling	2 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R124	Audio grid leak	0.5 meg.,$\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R125	Audio cathode	1500 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$
R201	Vibrator	100 ohms, $\frac{1}{2}$ watt	I.R.C.	BT-$\frac{1}{2}$

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT-1	Oscillator	RCA, Sylvania, or equiv.	6F6G
VT-2	Final amplifier	" " " "	6L6G
VT-3	Final amplifier	" " " "	6L6G
VT-4	Audio amplifier	" " " "	6F6G
VT-5	Modulator	" " " "	6L6G
VT-6	Modulator	" " " "	6L6G
VT-101	R-f amplifier	Sylvania, or equivalent	6S7G
VT-102	Converter	" " "	6D8G
VT-103	I-f amplifier	" " "	6S7G
VT-104	Detector	" " "	6T7G
VT-105	B-f oscillator	" " "	6S7G
VT-106	Audio amplifier	" " "	6K6G

2.55 Transformers

T1	Microphone	Thordarson	8378
T2	Driver	"	6778
T3	Modulation	"	10 M 84
T201	Power	"	12 R 88

2.56 Switches

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
SW-1	CW to phone & recv.	SPDT 3A 125-v	H & H	SPDT toggle with short nickel pl. shank
SW-2	Microphone switch	SPST	Integral with microphone	
SW-3	Transmitter filaments	SPST 10A 125-v	Bryant	IL-1311
SW-4	Dynamotor relay	SPST 3A 125-v	H & H	SPST toggle with short nickel pl. shank
SW-101	Receiver on-off	SPST 3A 125-v	H & H	SPST toggle with short nickel pl. shank
SW-102	B-f oscillator on-off	DPST 3A 125-v	H & H	DPST toggle with short nickel pl. shank
SW-103	AVC on-off	SPST 3A 125-v	H & H	SPST toggle with short nickel pl. shank

2.57 Terminal Strips

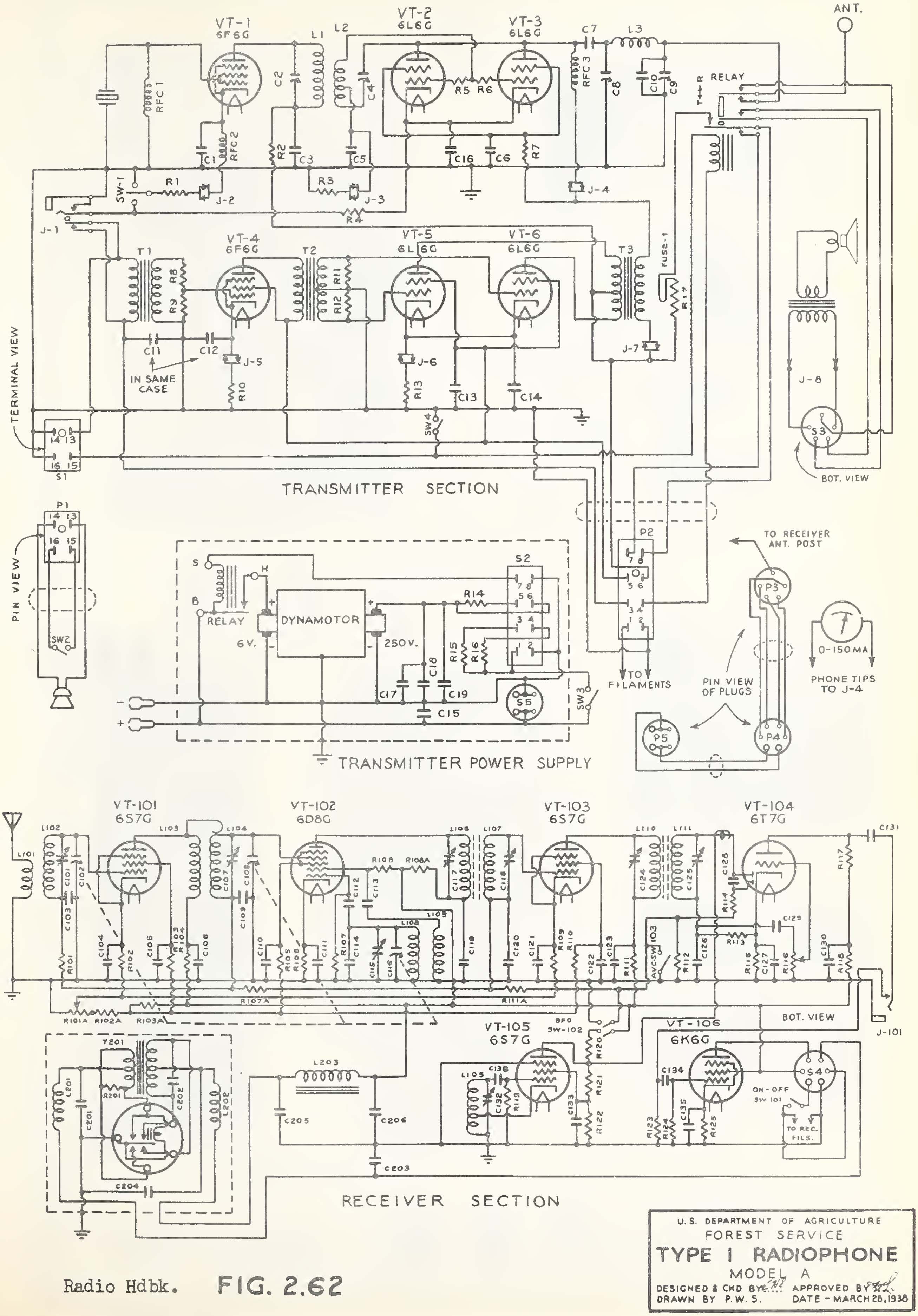
QUANTITY	DESCRIPTION	MANUFACTURER	TYPE
2	Tie point, 1 lug	Bud	367
3	" " 2 "	"	368
5	" " 5 "	"	374
2	" " 4 "	"	370

2.59 Miscellaneous

QUANTITY	DESCRIPTION	MANUFACTURER	TYPE
1	Microphone with built-in relay switch	Kellogg	FS21C
1	Cord, microphone, 4 conductor	Kellogg	F707
1	Plug, microphone	Jones	P-4-RST
1	Socket, microphone	Jones	S-4-AB
1	Speaker, 6" permanent magnet dynamic, with matching transformer	Wright DeCoster	582
2	Leads, speaker Each 9" #20 flexible hook-up wire, fitted with phone tips		
1	Jack, speaker	Mallory	401-S
1	Milliammeter, 0-150 ma.	Westinghouse	RX
1	Lead, milliammeter, flex red rubber covered wire, #20 AWG., fitted with phone tip, 15" long		
1	Lead, milliammeter, flex black rubber covered wire, #20 AWG., fitted with phone tip, 15" long		
6	Jacks, meter	Mallory	433
1	Relay, transmit-receive, with 6-volt AC coil and micalex base, DPDT and SPST	Leach	
1	Dynamotor, 6 volts primary, 250-volt 200 ma. secondary, with filter	Pioneer	E3
1	Relay, dynamotor	Pioneer	HR4002 6-v 7R
1	Lead, battery, 3' #12 flex BRC wire, white		

QUANTITY	DESCRIPTION	MANUFACTURER	TYPE
1	Lead, battery, 3' #12 flex BRC wire, black		
1	Sheath, battery leads, aluminized fabric		
2	Clips, battery, 1 painted red	Mueller	21-A
1	Socket, dynamotor base	Jones	S-8-AB
1	Socket, dynamotor base, 4-prong standard	Amphenol	S-4
1	Cable, transmitter power, 8-conductor, each #18 BRC wire, color coded, with fabric covering for entire cable, flexible	Lenz	Special
1	Plug, transmitter power cable	Jones	P-8-CCT
1	Cable, receiver power and antenna, Main cable: 3 conductor #18 flex. BRC wire, color coded, with fabric covering 15" long Dynamotor link: 2 6" #18 flex. BRC conductors Antenna link: 1 36" #18 rubber covered	Lenz	Special
1	Plug, receiver power cable	Amphenol	PM-4
1	Plug, receiver power cable	Eby	97B-515
1	Plug, receiver power cable	Eby	97C-515
1	Crystal, A-cut	Spokane	I
1	Holder, crystal	Spokane	I
1	Jack, key	Mallory	704A
2	Butt-ins	CPI	---

QUANTITY	DESCRIPTION	MANUFACTURER	TYPE
1	Jack phones	Mallory	702A
1	Vibrator	Mallory	245
12	Sockets, octal	Amphenol	S-8
1	Socket, 6-prong	Amphenol	S-6
1	Socket, 5-prong	Amphenol	S-5
2	Posts, binding, "X-L" pushpost	X-L	ANT
1	Dial	National	BM-1
2	Knobs	Bud	747
5	Shields	Bud	392
5	Grid clips	Bud	107



Radio Hdbk. FIG. 2.62

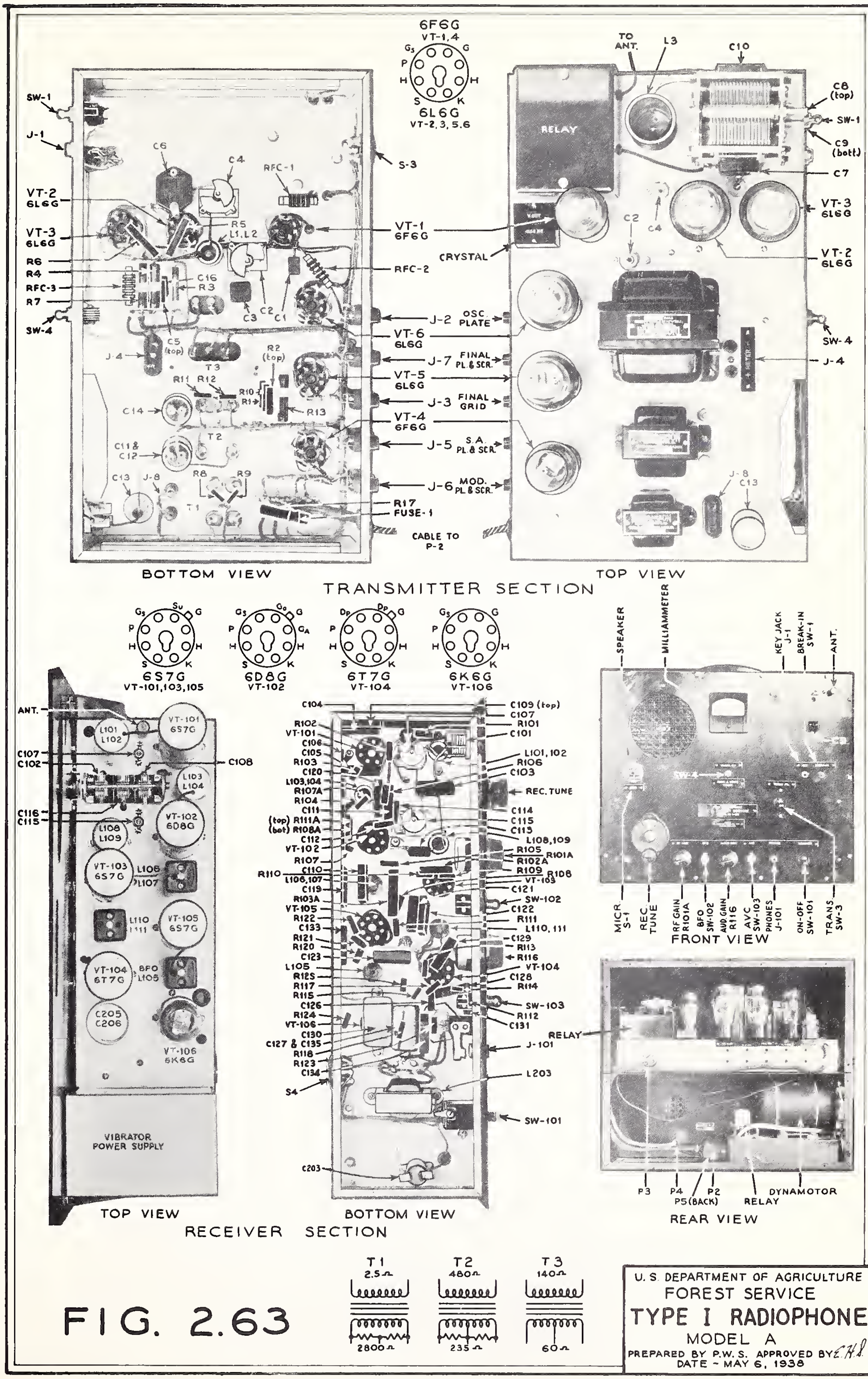


FIG. 2.63

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE I RADIOPHONE
MODEL A
PREPARED BY P.W.S. APPROVED BY E.H.L.
DATE - MAY 6, 1938

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0.0 General Description

The Type I, Model D Radiophone is a semi-portable transmitter-receiver which operates only from a storage battery similar to an automobile battery. It is intended for use in fire camps and in stations where commercial power is not available, but where facilities for charging batteries can be obtained. Both voice and c-w telegraph operation are provided. The rated transmitting range is 40 miles. The crystal-controlled transmitter operates on one of the frequencies assigned to the Forest Service between 2900 and 3500 kc, and has a rated power output of 9 watts. The microphone has a "push-to-talk" button for use during voice operation. The receiver is a sensitive superheterodyne which operates in the frequency range of 2900 to 3500 kc.

The Radiophone is housed in a rugged sheet-metal case with carrying handle. A compartment in the rear stores antenna, halyards, microphone, headphones, telegraph key, and battery leads, all of which are supplied with the Radiophone. The battery is not furnished.

0.1 Electrical Specifications

Frequency Range, Transmitter	One specific Forest Service frequency between 2900 and 3500 kc.
Frequency Control	Crystal
Type of Signal	Voice or C. W.
Distance Range	40 to 400 miles
Power Supply	6-volt storage battery
Power Output	9 Watts
Antenna	Half-wave, fed off-center
Tube Complement, Transmitter	1 Type 6K6G Oscillator 1 Type 807 Final Amplifier 2 Type 6V6G Modulators
Frequency Range, Receiver	2900 to 3500 kc.
Tube Complement, Receiver	1 Type 6S7G r-f Amplifier 1 Type 6D8G Converter 1 Type 6S7G i-f Amplifier 1 Type 6T7G Detector 1 Type 6K6G a-f Amplifier 1 Type 6S7G b-f Oscillator
Input	Hand Microphone or Telegraph key
Output	Speaker or headphones.

0.2 Physical Specifications

Radiophone Dimensions, Overall.	13" wide x 17" high x 14" deep.
Approximate Battery Dimensions.	10" long x 7" wide x 9" high
Radiophone weight, with all accessories except battery	66 lbs.
Approximate battery weight	40 lbs.

1.0 Detailed Description

The transmitter and receiver are built on separate chassis, the transmitter chassis occupying the upper half of the case, and the receiver chassis the lower half. Physical arrangement of components is shown in Fig. 2.63, the Photodiagram. Components may be identified by reference to 2.5, Parts List, and Fig. 2.62, the Schematic Diagram.

1.1 Transmitter Circuit

A Type 6K6G crystal oscillator excites a Type 807 final amplifier. The modulator consists of a pair of Type 6V6G tubes, operating Class AB. Grids of the modulator tubes are driven directly from the secondary of microphone transformer T-1, thus eliminating the need for an intermediate speech amplifier.

Referring to Fig. 2.62, the Schematic Diagram, R-1 is the oscillator grid leak, and L-1, C-4 form the oscillator plate tank. R-f voltage induced in L-2 excites VT-2, the final amplifier. Grid bias for VT-2 is derived from both grid leak R-7 and cathode dropping resistor R-8. The cathode bias resistor serves to limit off-resonance plate current during tuning operations. R-9 is a parasitic suppressor, and R-10 a screen-dropping resistor.

The panel meter may be used to indicate either grid current or plate current in the final amplifier, the selection being made by means of a small toggle switch SW-301 mounted over the modulation transformer T-2 inside the cabinet. Meter ranges are 0-10 ma for grid current, and 0-100 ma for plate current. After installation, the switch is left so that the meter indicates plate current. R-301 is the 100-ma shunt for plate current. R-13 provides a return path for grid current when panel meter is switched to measure plate current, and has sufficiently high resistance to prevent objectionable shunting action on the meter.

C-8 is a blocking capacitor which prevents final-amplifier plate voltage from reaching the final-amplifier plate coil or the antenna. L-3, C-9, C-10, and C-16 form the final-amplifier plate tank circuit. The arrangement of these elements is such that a pi-section impedance-matching network is obtained, with the result that the low impedance of the antenna wire is transformed to a higher impedance, thereby loading the final amplifier properly.

Referring to the audio section of the transmitter, the microphone is connected through its cord in series with the primary of microphone transformer T-1, current limiting resistor R-12, and the battery. A-f currents are bypassed around R-12 and the battery by capacitor C-11. Induced secondary voltage in T-1 is applied to grids of modulators VT-3 and VT-4. Cathode bias resistor R-11, by-passed by C-12, provides grid bias for modulators VT-3 and VT-4. Plates of VT-3 and VT-4 energize the primary of modulation transformer T-2. Plate and screen voltage is supplied to final amplifier VT-2 in series with the secondary of modulation

transformer T-2. The a-f voltage produced in the secondary of T-2 by the modulator is in series with the d-c plate and screen voltage. This results in plate modulation of final amplifier VT-2.

During c-w telegraph operation the primary of microphone transformer T-1 is short-circuited by contacts on the key jack. Keying is accomplished by interrupting the cathode return on final amplifier VT-2.

1.2 Receiver Circuit

The receiver is a sensitive superheterodyne, utilizing a Type 6S7G r-f stage, a Type 6D8G converter, a Type 6S7G i-f stage, a Type 6T7G detector and a-f amplifier, and a Type 6K6G a-f output stage. The b-f oscillator uses a Type 6S7G tube.

Referring to Fig. 2.62, the Schematic Diagram, it is seen that antenna current in L-101 induces voltage in grid coil L-102, which is tuned with padder capacitor C-101 and tuning capacitor C-102. Voltage developed in this resonant circuit is applied to the grid of r-f amplifier VT-101.

Plate current of VT-101 flows through L-103 and induces r-f voltage in grid coil L-104, which is tuned with padder capacitor C-107 and tuning capacitor C-108. Voltage developed in this resonant circuit is applied to the signal grid of converter VT-102.

L-105 is the tuned h-f oscillator grid coil, and is resonated with padder capacitors C-113 and C-114, and with tuning capacitor C-115. R-111 and C-112 are respectively the h-f oscillator grid leak and grid capacitor. L-106 is the anode grid coil.

Plate current of converter VT-102 flows through the tuned primary of i-f transformer T-101, and induces i-f voltage in the tuned secondary. This induced voltage is applied to the grid of i-f amplifier VT-103.

Plate current from i-f amplifier VT-103 flows through the tuned primary of i-f transformer T-102, and induces i-f voltage in the tuned secondary. This induced voltage is connected in series with the diode rectifier section of VT-104 and diode load resistor R-119. This results in the production of a voltage across R-119 corresponding with the modulation envelope of the i-f signal.

The second diode plate of VT-104 is effectively connected to the first diode plate for i-f currents, although it is isolated from the first plate for d-c voltage by blocking capacitor C123. Voltage applied to this second diode plate is connected in series with the diode rectifier, isolating resistor R-121, and A-V-C load resistor R-118. This results in the production of a d-c voltage across R-118 which is proportional to the carrier amplitude. This d-c voltage is

the A-V-C bias on VT-101, VT-102, and VT-103. R-104, R-108, and R-114 are filter resistors in the C-V-C supply. During reception of c-w telegraph signals the A-V-C feature is eliminated from the receiver, by grounding the A-V-C bus at the junction between R-114 and R-118. This ground is applied by contacts on the "B.F.O." switch, SW-101.

Manual "RF GAIN" potentiometer R-101 is connected in series with a bleeder circuit from the plate supply voltage. The slider of R-101 is connected to cathode returns of r-f and i-f amplifiers VT-101 and VT-103. Thus adjustment of R-101 varies the effective grid bias on these tubes, and thereby controls the gain.

Screen voltage for VT-101,VT-102,VT-103 is taken from the junction between R-102 and R-103, which are resistors in the same bleeder mentioned in the last paragraph.

VT-106 is the electron-coupled b-f oscillator, with its tuned circuit consisting of L-107 and C-131. Plate and screen voltages are supplied from the bleeder circuit consisting of R-127, R-128, and R-129. The output of the b-f oscillator is coupled into the i-f input to the diode by a small capacitance, which consists of a few turns of insulated hook-up wire wrapped around the lead to the diode plate.

Referring to the a-f amplifier section of the receiver, the a-f voltage developed across diode load resistor R-119 is applied to "AUDIO GAIN" potentiometer R-122 in series with blocking capacitor C-124. The slider of R-122 is connected to the grid of the triode section of VT-104. The output of this triode is resistance-coupled to a-f output amplifier VT-105, R-123 being the plate load resistor and R-125 the grid resistor. It will be noted that the coupling capacitance consists of two capacitors, C-127 and C-128, in series. A high resistance, R-126, is connected between the junction of these capacitors and ground. This arrangement practically eliminates the possibility of positive bias being applied to the grid of output amplifier VT-105 because of coupling capacitor leakage.

The output of amplifier VT-105 is matched to the low-impedance voice-coil by output transformer T-103. The speaker is a permanent-magnet dynamic.

The headphones jack is connected to the output of the triode section of VT-104.

1.3 Power Supply Circuit

Filaments of all tubes are heated directly from the battery. Transmitter and receiver have separate vibrator-type high-voltage power supplies. Grid bias voltages are obtained from cathode dropping resistors,

grid resistors, from the A-V-C bus, and from bleeder drop in manual "RF GAIN" control R-101. Details may be seen from inspection of Fig. 2.62, the Schematic Diagram.

The transmitter power supply unit contains two vibrator-type plate-supply units and a filter. Referring to Fig. 2.62, the Schematic Diagram, it is seen that primary voltage is supplied to the vibrators through contacts on Relay-201. Vibrator outputs are connected in parallel through their respective filter chokes, L-201 and L-202. C-201, C-202, and C-203 are filter capacitors.

The receiver power supply unit contains a single vibrator-type power supply and a capacitor-input filter. Primary voltage is supplied to the vibrator through contacts on "RECVR PWR" switch SW-202.

Battery drains are listed in Table 1.

Table 1

Battery Drains

Transmitter, Filaments only	2.2 Amperes
Transmitter Operating	13.5 to 15.5 Amperes. (Varies with Modulation)
Receiver, Filaments Only (Relay-201 energized)	1.35 Amperes
Receiver Operating, No Signal "RF GAIN" turned to maximum sensitivity	3.5 Amperes

1.4 Switching Circuits

Referring to Fig. 2.62, the Schematic Diagram, it is seen that "TRANS PWR" switch SW-201 interrupts the 6-volt power supplied to the transmitter for filaments, microphone, and for energizing Relay-1, the Send-Receive relay.

The winding of Relay-1 is connected in series with the 6-volt supply and contacts in the microphone "push-to-talk" switch SW-2. Contacts of "TRANS CW - RECV" switch SW-1 parallel the contacts of SW-2, so that Relay-1 may be energized by pushing the microphone switch or by operating the "TRANS CW - RECV" switch. With Relay-1 energized, its contacts perform the following functions:

(a) Antenna is switched from receiver to transmitter.

(b) Winding of Relay-201 is energized.

When Relay-201 is energized, 6-volt power is applied to the transmitter high-voltage power supply. When this relay is de-energized, 6-volt power is applied to the receiver high-voltage power supply. Also, load resistor R-201 is connected across the output of the transmitter high-voltage power supply filter to discharge the filter capacitors quickly. This rapid discharge is necessary to prevent the transmitter from continuing operation from energy stored in the capacitors, for a period of seconds after the microphone "push-to-talk" switch has been released. Such prolonged transmitter operation would cause objectionable noise in the receiver.

Referring to the receiver, "RECVR PWR" switch, SW-202 interrupts 6-volt power to receiver filaments and to the receiver high-voltage power supply. The "B.F.O." switch, SW-101, applies plate and screen voltage to b-f oscillator tube VT-106, and also grounds the A-V-C bus, so that the A-V-C feature will be eliminated during c-w telegraph reception.

1.5 Other Features

1.51 Antenna

The antenna is a half-wave off-center-fed doublet. For further information, see Sec. C9.101.

2.0 Adjustment and Repair, General

The following tools and equipment are needed for repair and adjustment of the Type I, Model D Radiophone.

(a) Usual complement of bench and hand tools.
(b) Tube checker.
(c) High-resistance d-c voltmeter, 1000 or more ohms per volt. Scales needed: 0-10, 0-250, 0-1000 volts.
(d) High resistance a-c voltmeter, copper-oxide-rectifier type, 1000 ohms per volt. Scales needed: 0-2.5, 0-10, 0-50, 0-250, and 0-1000 volts.
(e) Ohmmeter

Note: Items (c), (d), and (e) may be obtained in a single combination instrument.

(f) Cathode-ray Oscilloscope
(g) USFS Type A Test Set.
(h) Signal Generator, with range 2900 to 3500 kc, and also 465 kc.
(i) Audio power output meter. The 0-2.5 volt a-c range of item (d) may be used in place of item (i).

If the Radiophone fails to operate, the following procedure should be used to locate the trouble:

(1) See that cable terminals engage firmly in their receptacles, and that battery clips are making good contact with battery terminals. Make sure that the "+" battery clip, which is attached to the red wire, connects to the "+" battery terminal.

(2) See that the storage battery is well charged. A hydrometer will indicate a specific gravity of 1.280 for a fully charged battery, 1.250 for a half charge, and 1.220 for a discharged battery. Battery terminal voltage should be at least 5.7 volts. This measurement should be made with "TRANS PWR" and "RECVR PWR" switches turned "ON", and with the microphone button pressed.

(3) Examine antenna and lead-in wire. See that wires are in the clear, and make sure there are no broken connections.

2.1 Transmitter Data

If the transmitter fails to operate properly, make the tests outlined on "2.0 Adjustment and Repair, General". If this fails to clear the trouble, the next step is a series of tests which will indicate whether the trouble is in the power supply, r-f section, or modulator. Having thus localized the trouble, the search for faulty components may be concentrated within the section which is not performing properly.

2.11 Preliminary Tests to Localize Trouble

(1) Remove both transmitter and receiver chassis from cabinet. This is done by removing battery-cable terminals from both transmitter and receiver, then removing the eight screws which hold transmitter and receiver panels to the cabinet. It is necessary to remove the receiver part way first, so that the antenna connection from the bottom of the transmitter to the receiver antenna post can be disconnected. Inspect both chassis for apparent physical damage. Work the crystal and each tube in and out of its socket a few times to brighten the contacts. See that the crystal is inserted so that the "GRID" pin engages the ungrounded socket terminal.

(2) Insert battery-cable terminal in transmitter receptacle. Connect dummy antenna load between "ANT" post and chassis. For information concerning suitable dummy antenna load, see Sec. C12.403, "Dummy Antennas for Adjusting Transmitters". In the absence of a dummy antenna, the regular antenna may be used, in which case the lead-in wire is connected to the "ANT" post, and no connection is made to the chassis. The dummy antenna is preferable, because its use eliminates interference from the transmitter during the adjusting operations.

Turn "TRANS CW - RECV" switch to "RECV", and "TRANS PWR" switch "ON". After allowing 30 seconds for filaments to heat, momentarily press microphone switch SW-2. Note whether both relays (Relay-1 and

Relay 201) operate. Failure of relay operations may be caused by mechanical faults on the relay, or by faults in the circuits associated with the relay coils. These circuits include wiring, contacts on Relay-1, the microphone cord, and the microphone switch SW-2.

Note whether the power supply produces any unusual noise. Normally, the hum is barely audible, and a louder sound indicates power-supply overload. Do not permit sustained overload.

(3) Alternately press and release microphone switch SW-2 several times. Note whether action of both relays is rapid and positive. See that contacts engage firmly, and that they are in good condition. If it is necessary to dress these contacts, this should be done with the utmost care to insure that they will contact over their full surfaces. A suitable method is to fold a piece of crocus cloth so that the abrasive surface of the cloth is on the outside. Insert the folded cloth between the contacts, press the contacts together, and pull the cloth out. Repeat several times, thereby brightening the contact surfaces. In cases of severe contact pitting it may be necessary to use folded <u>fine</u> emery cloth before securing the final surface with crocus cloth.

(4) If both relays are in good condition, and power-supply unit is relatively quiet, press microphone switch SW-2 and measure voltage between ground and "B+" connection on Relay-201. If this voltage is substantially less than 300 volts, carefully unsolder from the relay terminal the wire which supplies plate power to the transmitter. Connect a 2000-ohm 50-watt resistor from this relay terminal to ground, and again measure voltage. If no 50-watt resistor is at hand, a 10-watt resistor may be used, provided the measurement is made quickly so the resistor does not overheat. If the voltage is still less than 300 volts, search for trouble in the power-supply section, as outlined in "2.3, Power Supply Data". However, if substitution of the 2000-ohm resistor for the wire to the transmitter restores "B+ " voltage from an abnormally low value to about 300 volts, a fault is indicated in the transmitter. Possible transmitter faults which may cause an excessive load on the power supply are ruptured capacitors and breakdown of insulation in wiring or in modulation transformer T-2.

(5) If the power supply produces normal voltage with the transmitter load, press microphone switch SW-2 and note reading on panel meter. When switched to measure plate current, meter range is 0-100 ma. Vary adjustment of "R" control, and note whether plate current dips as "R" is tuned through resonance, and note off-resonance plate current. Plate current at resonance should be 40-50 ma, and off resonance about 65 ma. Failure of plate current to dip through resonance suggests that the oscillator is not operating. If plate current dips through resonance, yet off-resonance plate current is abnormally low, the oscillator may not be operating properly, or a new final-amplifier tube (VT-2) may be needed.

(6) Turn meter switch SW-301 to "GRID". When switched to measure grid current, meter range is 0-10 ma. Press microphone switch SW-2 and note meter reading. A normal reading of from 2 to 4 ma indicates that the oscillator is operating. Return meter switch SW-301 to "PLATE".

(7) If preceding tests have indicated normal conditions, it may be assumed that a carrier is being produced, and the next step is to test for modulation. This may be done conveniently with a Type A Test Set. See Sec. C12.301, "Type A Test Set", Item 2.04. If no Type A Test Set is at hand, a radio receiver may be used. The receiver should be located far enough from the transmitter so that overloading in receiver circuits is avoided.

If the above test is not possible because of lack of equipment, modulator performance may be checked by measuring the a-f voltage induced in the secondary of the modulation transformer. Connect the prods of a copper-oxide-rectifier a-c voltmeter across the secondary of modulation transformer T-2. A blocking capacitor may be inserted in series with the voltmeter to eliminate the slight deflection caused by d-c drop in the winding. Switch the voltmeter to the 1000-volt scale, press microphone switch SW-2, and whistle into the microphone. The actual deflection observed will depend upon final-amplifier loading and the intensity of the sound input to the microphone. A typical deflection will be about 225 volts.

(8) If all the foregoing checks indicate normal conditions, it is probable that the transmitter is performing properly. If trouble is indicated in the r-f section, the modulator, or the power supply, the search for the faulty condition should follow the procedure outlined below under the appropriate heading. See "2.12 R-F Section, Adjustment and Repair", "2.13 Modulator, Adjustment and Repair", and "2.30 Power Supply Data".

2.12 R-F Section, Adjustment and Repair

(9) Measure tube element voltages. See tube-socket diagrams on Fig. 2.63, the Photodiagram. All filaments should have the full battery voltages applied to their terminals, and this should not decrease greatly when the microphone switch is pressed. Normal voltages of other elements should be approximately as listed in Table 1. Screen and cathode voltages on oscillator VT-1 and final amplifier VT-2 will be somewhat dependent upon adjustments, the values shown being normal for correct adjustment.

Table 1

Normal Tube-Element Voltages (Measured to Ground)

(a) VT-1 Oscillator (Type 6K6G)	
Plate Supply (Junction of R-5 and R-6)	240 to 225°
Screen	120 to 115°
Cathode Bias	Depends upon adjustment of C-4 and resulting plate current. Typical value, 12 volts.
(b) VT-2 Final Amplifier (Type 807)	
Plate (Measured on meter side of RFC-1)	290 to 270°
Screen	205 to 185°
Cathode Bias	Depends upon loading and resulting plate current. Typical value, 18 volts.
(c) VT-3 and VT-4 Modulators (Types 6V6G)	
Plates and Screens	305 to 295°
Cathode Bias	19 to 26°

°Varies with modulation.

(10) The next step is the retuning of the oscillator. See that the crystal is inserted so that the "GRID" pin engages the ungrounded terminal on the crystal socket. Turn meter switch SW-301 to "GRID", for which position the panel meter range is 0-10 ma. Switch the d-c voltmeter to the 10-volt scale and connect prods across R-5. (See Fig. 2.62, Schematic Diagram, and Fig. 2.63, Photodiagram). R-5 carries the oscillator plate current, and since its value is 1000 ohms, voltage drop across R-5, as indicated by the voltmeter, is equal to oscillator plate milliamperes. Turn oscillator plate capacitor C-4 to maximum capacitance. Press microphone switch SW-2, and slowly reduce the capacitance of C-4, watching both final amplifier grid current and oscillator plate current, as indicated by panel meter and external voltmeter, respectively. Oscillator plate current will dip sharply about the same time final-amplifier grid current starts. Continue to reduce the capacitance of C-4 until final amplifier grid current is roughly maximum.

Before completing the precise adjustment of the oscillator, the final amplifier should be resonated according to following paragraph. If there is a tendency toward unreliable starting, inspect crystal and crystal holder. Clean crystal, and see that holder does not bind edges of crystal.

(11) The next step is the adjustment of "R" and "L" control for proper loading and for resonance in the final-amplifier plate circuit. To make this adjustment, see that meter switch SW-301 is turned to "PLATE", for which position it will have a range of 0-100 ma. Press microphone switch SW-2, and tune "R" adjustment for minimum final-amplifier plate current, as indicated by panel meter. If this minimum current is less than 40-50 ma, turn "L" control so as to reduce capacitance of C-10, and

again tune "R" for minimum panel-meter indication; if more than 40-50 ma, turn "L" control so as to increase C-10 capacitance, and repeat adjustment of "R" control for minimum panel-meter indication. This series of alternate adjustments of "L" and "R" controls is repeated until panel meter indicates 40-50 ma when "R" is tuned for minimum current. The adjustment of the "R" control is the last adjustment made.

(12) Return meter switch SW-301 to "GRID". With 0-10 volt d-c meter connected across R-5, repeat the procedure of paragraph (10), adjusting oscillator tuning capacitor C-4 for maximum final-amplifier grid current. If C-4 is turned past this point, it is not permissible to make a slight re-adjustment of C-4 in the reverse direction. C-4 should be returned to maximum capacitance, and the procedure repeated. After making this adjustment, alternately press and release the microphone switch several times to make sure the oscillator starts reliably. Return meter switch SW-301 to "PLATE".

(13) Detune only the "R" control, and observe maximum off-resonance plate current. If this current is less than about 65 ma, the need for a new final-amplifier tube is indicated. This of course presupposes that all previous checks on plate voltage and excitation have been made. Retune "R" control for minimum plate current.

(14) It may be observed that there is no setting of the "L" control which will result in an indication of 40-50 ma when the "R" control is adjusted for minimum plate current. This situation may be the result of a fault in the antenna or lead-in-wire, or of an incorrect value of capacitance for loading capacitor padder C-16. If this difficulty is experienced, first inspect the antenna. If inspection shows the antenna to be in good shape, and in the clear, the capacitance of loading capacitor C-16 may need to be changed. If the minimum plate current loading obtainable by adjustment of "L" and "R" controls exceeds 40-50 ma, capacitance of C-16 should be increased; if maximum loading is less than 40-50 ma, C-16 should be decreased. Although trial adjustments may be made with any good mica capacitors at hand, the capacitor finally installed should have a rating of 1000 working volts (2500 d-c volts test). A Cornell-Dubilier Type 4 or an Aerovox Type 1456 is satisfactory.

(15) Turn meter switch SW-301 to "GRID". Press microphone switch SW-2 and note final-amplifier grid current. This should be between 2 and 4 ma. Return meter switch to "PLATE".

(16) If the initial adjustment of the transmitter was poor, it will be well to re-check tube-element voltages with Table 1.

(17) Before replacing transmitter in its cabinet, make sure meter switch SW-301 has been returned to "PLATE".

If a dummy antenna has been used during the foregoing adjustments, it will be necessary to re-resonate the final amplifier when the regular antenna is connected to the radiophone.

2.13 Modulator, Adjustment and Repair

(18) If the foregoing test of paragraph (7) indicates improper modulator performance, the first step is the checking of modulator-tube voltages. See Table 1.

(19) Examine microphone and microphone cable for physical damage. Make continuity tests between pins on microphone plug P-2 to determine if wires are open. Flex the cable while making the test to determine if the wires are open. Results of continuity tests should be as shown in Table 2.

Table 2

Normal Resistances Between Pins on Microphone Plug.

Continuity between Pins	Resistance, Micr. Button Released	Resistance, Micr. Button Pressed
#1 and #2	Open	1 ohm
#3 and #4	50 to 200 ohms	50 to 200 ohms
All Pins to Shell	Open	Open

(20) If the foregoing tests have not cleared the trouble, voltages across windings of microphone transformer T-1 and modulation transformer T-2 should be measured with a copper-oxide-rectifier type a-c voltmeter, while the technician or an assistant whistles into the microphone. Observed voltage will depend somewhat on the intensity of the sound directed into the microphone and upon final-amplifier loading. Typical values are listed in Table 3.

Table 3

Typical A-F Voltages across Windings of Microphone and Modulation Transformers

T-1 Primary	0.25 volt
T-1 Secondary	Meter barely deflects on 50-volt scale, due to meter loading on transformer.
T-2 Primary	400 volts
T-2 Secondary	225 volts

The presence or absence of normal voltages on the different windings will indicate the general location of the faulty component. Possible faults may include weak tubes, shorted or grounded transformer windings, and grounds or opens in the wiring. Transformer resistances may be compared with values given on Fig. 2.63, the Photodiagram.

(21) At the conclusion of repairs, the modulation should be checked, preferably with an oscilloscope. Using the directions of Sec.C12.402, "R-F Pick-Up Device for Oscilloscope", adjust controls on oscilloscope for viewing modulated carrier in screen. Note whether modulation is complete for normal speech into the microphone, and whether there is evidence of serious distortion. If no oscilloscope is on hand, an audible check of the modulation may be made by use of the Type A Test Set. See Sec. C12.301, "Type A Test Set", Item 2.04.

(22) In replacing the transmitter in its cabinet, see that meter switch SW-301 is turned to "PLATE".

2.2 Receiver Data

If the receiver fails to operate, make the tests outlined under "2.0 Adjustment and Repair, General". If this fails to clear the trouble, use the following procedure to locate the fault.

(1) Remove transmitter and receiver chassis from cabinet, using directions given in "2.1 Transmitter Data", paragraph (1). Work receiver tubes in and out of their sockets a few times to brighten contacts. Plug battery cable terminals into receptacles on both transmitter and receiver. Turn "TRANS PWR" and "RECVR PWR" switches "ON" and allow 30 seconds for filaments to heat.

(2) See that both transmitter relays are operating properly, and that their contacts are making firm connections. When Relay-1 is released the antenna is switched to the receiver, and when Relay-201 is released, 6-volt power is applied to the receiver power supply. If contacts on either relay are pitted, see"2.1 Transmitter Data", paragraph (3). Turn "TRANS PWR" switch "OFF".

(3) See that 6-volt power is reaching receiver filaments and power supply. Power supply may be assumed to be receiving power if it produces a low hum. Inspect each tube to see that it is lighted.

An unusually loud noise from the power supply may indicate an overload, or may be caused by vibration in the power-supply housing. Do not permit sustained overload.

(4) Measure "B+" voltage at the output of the power supply filter. With a well-charged storage battery this voltage should be about 175 volts. If the voltage is substantially less than this amount, carefully unsolder the wire which supplies plate power to the receiver, and connect a 5000-ohm 10-watt resistor from power-supply output to ground. Again measure power supply voltage. If voltage is still less than 175 volts, search for trouble in the power-supply section, as outlined in "2.3 Power Supply Data". However, if substitution of the

5000-ohm resistor for the wire to the receiver restores "B+" voltage from an abnormally low value to about 175 volts, a fault is indicated in the receiver. Possible receiver faults which may cause excessive load on the power supply are ruptured capacitors and breakdown of insulation in wiring or in output transformer T-103.

(5) If power supply voltage is normal, check voltages on all tube elements. For tube-socket diagrams see Fig. 2.63, the Photodiagram. Filaments should have the full battery voltage applied. Voltages on other elements should be approximately as shown in Table 4. Measurements should be made with "R-F GAIN" knob turned all the way to the right.

Table 4

Normal Tube-Element Voltages (Measured to Ground)

(a) VT-101 R-5 Amplifier (Type 6S7G)

Plate Volts	170
Screen Volts	100
Cathode Bias	3

(b) VT-102 Converter (Type 6D8G)

Plate Volts	170
Screen Volts	95
Anode-Grid Volts	105
Cathode Bias	3

(c) VT-103 I-F Amplifier (Type 6S7G)

Plate Volts	170
Screen Volts	100
Cathode Bias	3

(d) VT-104 Detector and Audio (Type 6T7G)

Plate Volts	110^{o}
Cathode Bias	1.7

(e) VT-105 Audio Output (Type 6K6G)

Plate Volts	170
Screen Volts	175
Cathode Bias	16

(f) VT-106 B-F Oscillator (Type 6S7G)

Plate Volts	31^{o}
Screen Volts	12^{o}

^{o}A 1000-ohms-per volt instrument will not indicate accurately for measurements marked "o" A 20,000-ohms-per volt instrument should be used.

If there are serious departures from tabulated tube-element voltages, examine components associated with the tube-elements in question. Search for shorted capacitors, and for resistors which show visible effects of over-heating.

(6) With "RECVR PWR" and "B.F.O." switch both turned "ON", turn both "R-F GAIN" and "AUDIO GAIN" knobs all the way to the right. The presence of a normal rushing sound in the speaker indicates that the audio section and at least some of the preceding section of the receiver is operating. As a further check, remove the grid clip from detector-audio tube VT-104, and with the thumb touching the tube shield, intermittently touch the grid connection on the tube. Removal of the grid clip from the tube should silence the rushing sound, and the intermittent touching of the grid connection should produce clicks in the speaker. If the foregoing audible clicks are not evident, trouble is indicated in the audio amplifier sec.of receiver. In searching for such trouble, try new tubes in VT-104 and VT-105 sockets. Compare winding resistances of T-103 with values shown on Fig. 2.63, the Photodiagram. Examine resistors and capacitors associated with the audio amplifier section of the receiver.

(7) With both gain controls adjusted for maximum gain, so that the rushing sound is produced in the speaker, and with the "B.F.O." switch turned "ON", touch the grid-cap connection of i-f amplifier VT-103, converter VT-102, and r-f amplifier VT-101. The noise should dip markedly in each case, the dip being most pronounced for the tubes nearest in the circuit to detector VT-104. If touching the grid of a particular tube produces no effect, it may be assumed that there is trouble between the tube and the output of the second detector. This trouble may be a faulty tube or other component, or serious misalignment of i-f transformers, such as might be caused by unskilled efforts to retune these transformers. Minor misalignments, such as normal shifting of adjustments, would not cause this trouble.

(8) The performance of the i-f, converter, and r-f stages may be checked by applying a modulated signal from a signal generator to grids of these three tubes. Using the assembly and the technique described in Sec. C12.401, "Coupling Network for Introducing Signal into Radio Receiver", apply 465-kc signal to the grids of VT-103 and VT-102. Apply r-f signal at a frequency within the range of the receiver to grids of VT-102 and VT-101. It will be necessary to tune the receiver to the frequency of the applied r-f signal.

For a given sound intensity at the speaker, more signal input will be required when introduced at the i-f amplifier grid than when introduced at the converter grid. Similarly, more signal input will be required at the converter grid than at the r-f amplifier grid. Thus when the signal generator input is successively moved from VT-103 toward VT-101, a decrease in signal input for the same audible output should be noted for each move.

If the signal generator can be adjusted to give 30% modulation and has a calibrated output, input signals may be compared with values in Table 5, which lists normal inputs for 50 milliwatts output. Receiver output may be measured by connecting an output meter in place of the speaker, or by connecting a 0-2.5 volt copper-oxide-type a-c voltmeter across the voice coil terminals. For the latter connection, a deflection of 0.55 volt indicates 50 milliwatts output.

Table 5

Normal Signal Inputs for 50 Milliwatts Output

(Signal modulated 30% at 400 cycles)

I-F Grid,	465 kc	4900 microvolts
Converter Grid	465	90
Converter Grid	3500	108
R-F Grid	3500	6.5
Antenna Post °	3500	1.3

°In series with IRC Type BT-1/2 400-ohm 1/2 watt resistor.

If above measurements show serious departures from tabulated signal-input levels, or if a lack of gain is evident in some stage, new tubes should be tried. Examine components associated with the faulty stage. If this does not clear the trouble, re-align the i-f and r-f circuits, using the following directions of 2.21, "Alignment of I-F and R-F Circuits".

2.21 Alignment of I-F and R-F Circuits

(9) Receiver alignment should be undertaken only if necessary, and only by a competent technician.

Connect an output meter in parallel with the speaker terminals. If it were desired to have the output meter indicate true receiver output, for instance, to facilitate comparison of observed signal inputs with values listed in Table 5, it would be necessary to disconnect one speaker terminal so that the entire receiver output would be dissipated in and measured by the output meter. However, simply connecting the output meter in parallel with the speaker will provide comparative indications which are adequate for alignment. If no output meter is at hand, the 0-2.5 volt scale of a copper-oxide-rectifier type a-c voltmeter may be used. Connect voltmeter prods in parallel with speaker terminals. A deflection of 0.55 volt indicates 50 milliwatts output.

(10) Using the assembly and technique described in Sec. C12.401, "Coupling Network for Introducing Signal into Radio Receiver", apply modulated 465-kc signal from a signal generator to the grid of i-f amplifier VT-103.

Using a fibre screwdriver, carefully adjust i-f tuning capacitors C-134 and C-135 on second i-f transformer T-102 for maximum deflection of output meter. Signal input level should be adjusted so that output meter deflects about to the 50-milliwatt indication, but not off scale nor sufficiently high to permit overloading in receiver circuits. It may be necessary to decrease this signal level as the transformer adjustment is improved, to keep the meter from going off scale.

(11) Move the 465-kc signal input to the grid of converter tube VT-102, and replace the normal grid clip on VT-103. Using the same general instructions stated in the preceding paragraph, re-adjust i-f tuning capacitors C-132 and C-133 on first i-f transformer T-101 for maximum deflection of output meter. As noted in Table 5, the input signal for constant output should be much less when signal is applied to converter VT-102 than when applied to i-f amplifier VT-103.

(12) Attach signal generator cord to the antenna post. The grounded cord conductor should be connected to the chassis, and the ungrounded conductor to the antenna post in series with a 400-ohm 1/2-watt carbon or metallized resistor. Adjust signal generator frequency to 3500 kc, tune in signal on receiver and note receiver dial reading. This reading should be about 90. If it differs from 90 by more than 5 scale divisions, make the adjustments of the following paragraph (13) before aligning the r-f circuits. If receiver dial reading is within the above limits, adjust signal input from signal generator for a proper deflection of the output meter. Carefully retune receiver tuning knob for maximum output meter deflection. Adjust padder capacitors C-101 and C-107 for maximum meter deflection.

(13) If the 3500-kc signal from the signal generator is tuned in at a dial reading that differs from 90 by more than 5 scale divisions, the calibration of the signal generator should be checked. This may be done with accuracy sufficient for the purpose by feeding modulated signal from the Type A Test Set into the receiver. See Sec. C12.301, "Type A Test Set", Item 1.3. If the dial reading is roughly the same for the signals from both the signal generator and the Type A Test Set, when both are adjusted for 3500 kc, the calibration of the signal generator may be accepted as sufficiently accurate.

Connect output from Signal generator to grid of converter VT-102, using the assembly and directions in Sec. C12.401, "Coupling Network for Introducing Signal into Radio Receiver". With signal generator set for 3500 kc and receiver dial set at 90, tune in signal by adjusting oscillator padder C-114. To make sure that the h-f oscillator is tuned to the high-frequency side of the signal frequency, leave the receiver adjustment fixed and retune the signal generator in the neighborhood of 4230 kc. If the oscillator is operating on the high-frequency side of the signal frequency, the receiver should respond to the image frequency of 4230 kc (signal frequency plus twice i-f frequency).

When the above adjustment and check have been made, replace the normal grid clip on converter VT-102 and perform the adjustment of the foregoing paragraph (12).

(14) Set input signal frequency on 3200 kc and again tune signal in with receiver tuning knob, making a precise tuning adjustment for maximum meter deflection. Insert each end, in turn, of a tuning wand (such as the "Aladdin Resonator")into antenna coil L-102 and r-f coil L-104. If tracking is correct, both of these coils should be resonated with the signal frequency, and insertion of either end of the wand should cause a decrease in indicated output. However, if tracking is imperfect, insertion of one end of the wand will cause a decrease in output, while insertion of the other end will result in an increase. If an increase of output is observed when the powdered-iron end of the wand is inserted, more capacitance is required to resonate the coil under test; if output increases with the brass end, less capacitance is needed.

Make the same tests with a 2900-kc signal. If tracking is only slightly imperfect, no further adjustment is needed. However, if these tests indicate poor tracking, carefully bend plates of tuning capacitors C-102,and C-108 so as to make the capacitance changes which the foregoing tests indicate are necessary. Make sure that plates are not so close as to permit possible contact between them. It should be noted that the front section of the 3-gang tuning capacitor tunes the antenna coil, L-102, and the rear section tunes the r-f coil, L-104.

It is not necessary to insert the tuning wand into the oscillator coil, L-105, nor to make any adjustment of the oscillator tuning capacitor, C-115, which is the center section of the 3-gang capacitor.

After making necessary adjustments on tuning capacitors, again check tracking on 3500, 3200, and 2900 kc.

Of course, if the receiver has a frequency range different from the 2900 to 3500 kc range prevalent throughout the Forest Service, as for instance, equipment supplied to other agencies, the above frequency figures need to be revised to include the two ends and the center of the tuning range.

2.22 Adjustment of B-F Oscillator

To adjust the b-f oscillator, connect the signal-generator cord to the antenna post, adjust signal frequency to some frequency within the tuning range of the receiver, and carefully tune in the signal, making the precise tuning adjustment for maximum output meter deflection. Switch modulation off the signal, and turn "B.F.O." switch "ON". Adjust b-f oscillator tuning capacitor C-131, which is in the same can with b-f oscillator coil L-107, so that the pitch of the note heard in the speaker is about 1000 cycles.

2.3 Power Supply Data

2.31 Transmitter Power Supply

If the test outlined in "2.1 Transmitter Data", paragraph (4), shows that the power supply is defective, the following procedure should be used to locate the trouble:

(1) Each vibrator can be inserted in its socket in either of two ways. See that each vibrator is so inserted that the "-" sign at the top of the vibrator is toward the rear of the chassis.

(2) See that the selector switch SW-203 is on position #4 on both "vibrapack" units. This switch is mounted on the side of the "vibrapack" chassis.

(3) Measure voltage at the "A HOT" terminals of the "vibrapack". This voltage should be at least 5.7 volts. Lower voltage may indicate a fault in one or both "vibrapack" units. Do not permit sustained overload.

(4) Remove wires from "B+" terminals on both "vibrapacks". With the vibrator removed from one "vibrapack", measure no-load voltage from ground to the "B+" terminal on the second "vibrapack". Replace the first vibrator in its same socket, observing the caution of paragraph (1) above, and remove the second vibrator. Measure no-load voltage from ground to the "B+" terminal on the first "vibrapack". While making each measurement the relay should be operated and released several times to determine if the vibrator starts reliably, and if there is any tendency for intermittent operation. A barely audible hum should be produced by the vibrator while it is operating.

Normally both measurements should show about 400 volts, assuming an input voltage of 6 volts.

(5) In the above tests using single vibrators, a vibrator may be assumed to be in good order if it starts reliably and produces normal voltage. If low or zero voltage is observed, try substituting a new vibrator, or one known to be in good order. If this clears the trouble, it is necessary to determine whether the vibrator has simply worn out, or if it was damaged by faults in associated circuits. See Sec. C13.9, Type K, Model A, Item 2.3, Power Supply Data, paragraph (5).

(6) If a vibrator has been replaced, which tests of paragraph (5) above have shown to be sticking, the buffer capacitor C-204 in the associated "vibrapack" should be tested to make sure it is not shorted, open, or of incorrect capacitance. See Sec. C13.9, Type K, Model A, Item 2.3, Power Supply Data, paragraph (11).

(7) If the location of "vibrapack" trouble is still in doubt, check all components within the unit, such as r-f filter capacitors and chokes, transformer, and selector switch SW-203. Check wiring for opens, grounds, or shorts.

2.32 Receiver Power Supply

If the test outlined in "2.2 Receiver Data", paragraph (4), shows that the power supply is defective, the following procedure should be used to locate the trouble:

(1) Remove lid from power-supply shield. The vibrator can be inserted into its socket in either of two ways. See that it is inserted so that the "-" sign at the top of the vibrator is toward the front of the chassis.

(2) Measure voltage at the power-supply input. This may be done by touching voltmeter prod to the correct terminal on "RCVR PWR" switch, SW-202. Measured voltage should be at least 5.7 volts. Lower voltage may indicate a fault in the power-supply unit. Do not permit sustained overload.

(3) Try substituting a new vibrator, or one known to be in working order, observing the caution of paragraph (1), above, This vibrator is the same type as those used in the transmitter power supply. If this clears the trouble, and produces normal voltage of about 175 volts at the output of the power-supply filter, see instructions in paragraph (8), below.

(4) If the procedure of the last paragraph did not clear the trouble, leave the new vibrator in the socket and carefully unsolder the wire from the power supply to the filter input. Measure voltage at the power supply output. If removal of the filter restores normal voltage, test filter capacitors C-211 and C-212 for short-circuits, and test filter choke L-203 for ground and for possible open. Normal resistance of L-203 is 500 ohms. Replace defective components.

(5) If this does not clear the trouble, check all components within the power-supply unit, such as r-f filter capacitors and chokes and transformer. Check wiring for opens, grounds, short-circuits, and poor connections.

(6) When normal operation of the power-supply unit and the filter has been restored, replace the original vibrator in its socket, observing the caution mentioned in paragraph (1), above. Measure voltage at the output of the power-supply filter. Alternately turn "RCVR PWR" switch SW-202 on and off several times to determine if the vibrator starts reliably. A barely audible hum should be produced by the vibrator while it is operating. If the original vibrator is unsatisfactory, make a replacement.

(7) Upon replacing a vibrator, it is necessary to determine whether the vibrator has simply worn out, or if it was damaged by faults in associated circuits. See Sec. C13.9, Type K, Model A, Item 2.3, Power Supply Data, paragraph (5).

(8) If the tests of paragraph (7) above show that the replaced vibrator was sticking, the buffer capacitor C-207 should be tested to make sure it is not open, shorted, or of incorrect capacitance. See Sec. C13.9, Type K, Model A, Item 2.3, Power Supply Data, paragraph (11). For rated capacitance of buffer capacitor C-207, see "2.5, Parts List".

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C-1	Oscillator Cathode Bypass	.005 mfd. mica	Aerovox	1460
C-2	Oscillator Screen Bypass	.005 mfd. mica	Aerovox	1460
C-3	Oscillator Plate Return Bypass	.005 mfd. mica	Aerovox	1460
C-4	Oscillator Plate Tuning	25 mmf variable	Hammarlund	APC-25 Special Double-Spaced Cadmium-Plated
C-5	Final Amplifier Grid Return Bypass	.004 mfd. mica	(Aerovox (Solar	1467) Or Equivalent MW-1237
C-6	Final Amplifier Cathode Bypass	.004 mfd. mica	Aerovox	1460
C-7	Final Amplifier Screen Bypass	.002 mfd. mica	(Aerovox (Solar	1467 Or Equivalent MW-1233
C-8	Final Amplifier Plate Blocking	.002 mfd. mica 2500-V test	(Aerovox (Cornell-Dubilier	1456) 4-22020
C-9	Final Amplifier Tuning	365 mmf variable	Cardwell	MR-365-BS
C-10	Final Amplifier Loading	365 mmf variable	Cardwell	MR-365-BS
C-11	Microphone Supply Bypass	20 mfd.150 volts) Electrolytic)	Mallory	FPD-208
C-12	Modulator Cathode Bypass	20 mfd. 150 volts) Electrolytic)	Note: In serial Nos. I-40 and I-41, C-11 and C-12 each consisted of a Mallory Type BN-226 10-10 mfd. 75-V electrolytic, with dual sections connected in parallel. Type BN-226 is no longer available.	
C-16	Additional Final Loading	.00025 mfd. mica 2500-V test	(Aerovox (Cornell-Dubilier	1456) 4-23025)

Above value for C-16 is for matching Forest Service half-wave single-wire-feed antenna. For matching 75-ohm line, use .002 mfd. 2500-V test mica capacitor.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C-101	Antenna Padder	50 mmf variable	Hammarlund	APC-50 Cadmium plated
C-102	Antenna Tuning	25 mmf variable	Hammarlund	Note 1
C-103	R-F Amplifier Grid Return Bypass	.01 mfd.600-V paper	Solar	S-0221
C-104	R-F Amplifier Cathode Bypass	.1 mfd. 400-V paper	Solar	S-0238
C-105	R-F Screen Bypass	.02 mfd. 600-V paper	Solar	S-0224
C-106	R-F Plate Return Bypass	.01 mfd.600-V paper	Solar	S-0221
C-107	Converter Grid Padder	50 mmf variable	Hammarlund	APC-50,Cadmium plated
C-108	Converter Grid Tuning	25 mmf variable	Hammarlund	Note 1
C-109	Converter Grid Return Bypass	.01 mfd.600-V paper	Solar	S-0221
C-110	Converter Screen Bypass	.02 mfd.600-V paper	Solar	S-0224
C-111	Converter Cathode Bypass	.1 mfd.400-V paper	Solar	S-0238
C-112	H-F Oscillator Grid	.00005 mfd.mica	(Aerovox (Solar	1468) MO-MW-1410)
C-113	H-F Oscillator Padder	.00004 mfd.mica	(Aerovox (Solar	1468) MO-1408)
C-114	H-F Oscillator Padder	50 mmf variable	Hammarlund	APC-50,Cadmium plated
C-115	H-F Oscillator Tuning	50 mmf variable	Hammarlund	Note 1
C-116	H-F Oscillator Anode Grid Blocking	.001 mfd. mica	(Aerovox (Solar	1465) MT)
C-117	Converter Plate Return Bypass	.02 mfd.600-V paper	Solar	S-0224

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C-118	I-F Amplifier Grid Return Bypass	.01 mfd.600-V paper	Solar	S-0221
C-119	I-F Amplifier Cathode Bypass	.1 mfd.400-V paper	Solar	S-0238
C-120	I-F Amplifier Screen Bypass	.02 mfd.600-V paper	Solar	S-0224
C-121	I-F Amplifier Plate Return Bypass	.02 mfd.600-V paper	Solar	S-0224
C-122	Diode Detector Load Bypass	.00025 mfd.mica	(Aerovox (Solar	1465) MT-1319)
C-123	A-V-C Diode Plate Coupling	.00025 mfd.mica	(Aerovox (Solar	1465) MT-1319)
C-124	Volume Control Blocking	.01 mfd.600-V paper	Solar	S-0221
C-125	Detector Cathode Bypass	20 mfd.150-V Electrolytic)	Mallory	FPD-208
C-127	Output Amplifier Cathode Bypass	20 mfd.150-V Electrolytic)	Note: In serial Nos. I-40 and I-41,C-125 and C-126 are provided in a single Mallory type BN-226 dual 10-10 mfd.unit. Type BN-226 is no longer available.	
C-126	A-F Coupling	.1 mfd.400-V paper	Solar	S-0238
C-128	A-F Coupling	.01 mfd.600-V paper	Solar	S-0221
C-129	B-F Oscillator Screen Bypass	.01 mfd.600-V paper	Solar	S-0221
C-130	B-F Oscillator Grid	.00025 mfd.mica	(Aerovox (Solar	1468) Note 2 MO-1419)
C-131	B-F Oscillator Tuning	Mica Compression Capacitor		Integral with L-107
C-132	1st I-F Transformer Primary Tuning	Mica Compression Capacitor		Integral with T-101

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C-133	1st I-F Transformer Secondary Tuning	Mica Compression Capacitor	Integral with T-101	
C-134	2nd I-F Transformer Primary Tuning	Mica Compression Capacitor	Integral with T-102	
C-135	2nd I-F Transformer Secondary Tuning	Mica Compression Capacitor	Integral with T-102	

Note 1: C-102, C-108, and C-115 are sections of a special 3-gang capacitor, Hammarlund 25-50-25 mmf sections, with Hammarlund HFD type construction.

Note 2: In same can with L-107.

C-201	Transmitter Power Supply Filter	8-8-8 mfd.525-V Electrolytic	Mallory	RM-265
C-202	Transmitter Power Supply Filter			
C-203	Transmitter Power Supply Filter			
C-204	Transmitter Vibrator Buffer	.005 mfd.1600-V Oil-Filled	Mallory	A-40980-1*
C-205	Vibrapack R-F Filter	.1 mfd.400-V paper	Mallory	TP-428*
C-206	Vibrapack Filter	.5 mfd.100-V paper	Mallory	RF-481*
C-207	Receiver Vibrator Buffer	.007 mfd.oil-filled	Aerovox	1130
C-208	Receiver Power Supply R-f Filter	.05 mfd.600-V paper	Solar	S-0230
C-209	Receiver Power Supply Filter	.5 mfd.100-V paper	Mallory	RF-481
C-210	Receiver Power Supply Filter	.5 mfd.100-V paper	Mallory	RF-481

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C-211	Receiver Power Supply Filter)	) 8-8 mfd.525-V Electrolytic	Solar	D-820
C-212	Receiver Power Supply Filter)			

* Part of Mallory Type VP-552 Vibrapack

2.52 Inductors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L-1	Oscillator Plate	45 turns #28 enameled wire close-wound on National Type XR-2 coil form.		
L-2	Final Grid	18 turns #32 enameled wire close-wound, fitted inside form for L-1.		
L-3	Final Plate	36 turns #22 enameled wire wound on National Type XR-2 form, threaded 30 turns per inch.		
L-101) L-102)	Antenna Coil		Miller	Style 5853,Type 32-618.
L-103) L-104)	Converter Coil		Miller	Style 5853,Type 32-620
L-105) L-106)	H-F Oscillator Coil		Miller	Style 5853,Type 32-619
L-107	B-F Oscillator Coil		Aladdin	C-350
L-201	Transmitter Power Supply Filter	5 henries,80 ma.	Thordarson	T-57C51
L-202	Transmitter Power Supply Filter	5 henries,80 ma	Thordarson	T-57C51

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L-203	Receiver Power Supply Filter	14.5 henries, 35 ma.	Halldorsen	T-391
RFC-1	Final Plate Choke	2 mh, 125 ma	(Hammarlund (National (Coto	CH-X) R-100) CI-11)
RFC-201	Vibrapack Filter		Mallory	RF-583*
RFC-202	Vibrapack Filter		Mallory	A-40919-1*

* Part of Mallory Type VP-552 Vibrapack.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
RFC-203	Receiver Power Supply Filter	28 turns #16 enameled wire wound into self-supporting coil 1/2" outside diameter.		
RFC-204	Receiver Power Supply Filter	2 mh 125 ma	(Hammarlund (National (Coto	CH-X) R-100) CI-11)

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-1	Oscillator Grid Leak	50,000 ohms, 1/2 watt	IRC	BT-1/2
R-2	Oscillator Cathode	1,000 " 1 "	IRC	BT-1
R-3	Oscillator Screen Voltage Divider	25,000 " 1 "	IRC	BT-1
R-4	Oscillator Screen Voltage Divider	15,000 " 2 "	IRC	BT-2
R-5	Oscillator Plate Return Isolating	1,000 " 1 "	IRC	BT-1
R-6	Oscillator Plate and Screen Dropping	4,000 " 2 "	IRC	BT-2
R-7	Final Amplifier Grid Leak	15,000 " 1 "	IRC	BT-1

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-8	Final Amplifier Cathode	250 ohms. 2 watt	IRC	BT-2
R-9	Final Amplifier Parasitic Suppressor	50 " 1/2 "	IRC	BW-1/2
R-10	Final Amplifier Screen Dropping	15,000 " 2 "	IRC	BT-2
R-11	Modulator Cathodes	250 " 10 "	Ohmite	Brown Devil
R-12	Microphone Filter	100 " 1/2 "	IRC	BW-1/2
R-13	Final Amplifier Grid Return	500 " 1/2 "	IRC	BT-1/2
R-101	Manual Gain Control Potentiometer	5,000 ohms	Centralab	72-110
R-102	Voltage Divider	20,000 " 1 Watt	IRC	BT-1
R-103	Screen Voltage Dropping	7,500 " 1 "	IRC	BT-1
R-104	R-F Amplifier Grid Return Isolating	0.25 Megohm 1/2 Watt	IRC	BT-1/2
R-105	R-F Amplifier Cathode	400 ohms 1/2 "	IRC	BT-1/2
R-106	R-F Amplifier Screen Isolating	1,000 " 1/2 "	IRC	BT-1/2 Note 3
R-107	R-F Amplifier Plate Return Isolating	1,000 " 1/2 "	IRC	BT-1/2 Note 3
R-108	Converter Grid Return Isolating	0.25 Megohm 1/2 "	IRC	BT-1/2
R-109	Converter Screen Isolating	1,000 ohms 1/2 "	IRC	BT-1/2 Note 4
R-110	Converter Cathode	300 " 1/2 "	IRC	BT-1/2
R-111	H-F Oscillator Grid Leak	50,000 " 1/2 "	IRC	BT-1/2
R-112	H-F Oscillator Anode Grid Dropping	25,000 " 1/2 "	IRC	BT-1/2

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-113	Converter Plate Return Isolating	1,000 ohm 1/2 watt	IRC	BT-1/2 Note 4
R-114	I-F Amplifier Grid Return Isolating	0.25 Megohm 1/2 Watt	IRC	BT-1/2
R-115	I-F Amplifier Cathode	400 ohms 1/2 Watt	IRC	BT-1/2
R-116	I-F Amplifier Screen Isolating	1,000 " 1/2 "	IRC	BT-1/2 Note 3
R-117	I-F Amplifier Plate Return Isolating	1,000 " 1/2 "	IRC	BT-1/2 Note 3
R-118	A-V-C Load	I Megohm 1/2 "	IRC	BT-1/2
R-119	Diode Detector Load	0.5 Megohm 1/2 "	IRC	BT-1/2
R-120	Detector Cathode	3,000 ohms 1/2 "	IRC	BT-1/2
R-121	A-V-C Diode Plate Isolating	0.5 Megohm 1/2 "	IRC	BT-1/2
R-122	Volume Control Potentiometer	0.5 "	Centralab	72-105
R-123	Audio Amplifier Plate Load	0.1 " 1/2 "	IRC	BT-1/2
R-124	Output Amplifier Cathode	1,500 ohms 1/2 "	IRC	BT-1/2
R-125	Output Amplifier Grid	0.5 Megohm 1/2 "	IRC	BT-1/2
R-126	Audio Coupling	2 " 1/2 "	IRC	BT-1/2
R-127	B-F Oscillator Screen Voltage Divider	0.1 " 1/2 "	IRC	BT-1/2
R-128	B-F Oscillator Screen Voltage Divider	0.1 " 1/2 "	IRC	BT-1/2
R-129	B-F Oscillator Plate and Screen Dropping	0.25 " 1/2 "	IRC	BT-1/2
R-130	B-F Oscillator Grid Leak	0.1 " 1/2 "	IRC	BT-1/2 Note 2

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-201	Transmitter-Power-Supply Filter Discharging.	200 ohms 10 watt	Ohmite	Brown Devil
R-202	Transmitter-Power-Supply Buffer Capacitor Series	5,000 " 1/2 "	(Mallory (IRC	A-40389-3)* BT-1/2)
R-203	Receiver Power Supply	100 " 1/2 "	IRC	BW-1/2
R-204	Receiver-Power-Supply Buffer Capacitor Series	5,000 " 1/2 "	IRC	BT-1/2

* Part of Mallory Type VP-552 Vibrapack
Note 2: In same can with L-107.
Note 3: In some receivers 1250 ohms has been used instead of 1000 ohms. Value is not critical.
Note 4: In some receivers 1500 ohms has been used instead of 1000 ohms. Value is not critical.

2.54 Tubes

SYMBOL	COMPONENT	MANUFACTURER	TYPE
VT-1	Oscillator	Sylvania or equivalent	6K6G
VT-2	Final Amplifier	RCA	807
VT-3	Modulator	Sylvania or equivalent	6V6G
VT-4	Modulator	Sylvania or equivalent	6V6G
VT-101	R-F Amplifier	Sylvania or equivalent	6S7G
VT-102	Converter	Sylvania or equivalent	6D8G
VT-103	I-F Amplifier	Sylvania or equivalent	6S7G
VT-104	Detector	Sylvania or equivalent	6T7G
VT-105	Output Amplifier	Sylvania or equivalent	6K6G
VT-106	B-F Oscillator	Sylvania or equivalent	6S7G

2.55 Transformers

SYMBOL	COMPONENT	MANUFACTURER	TYPE
T-1	Microphone	Phelps-Dodge	Inca 6985
T-2	Modulation	" "	" 7021
T-101	I-F Input	Aladdin	C-101M
T-102	I-F Output	"	C-200M
T-103	Audio Output	Jensen	Z-2370
T-201	Transmitter Power Supply Transformer	Mallory	B-40966-1*
T-202	Receiver Power Supply Transformer	Thordarson	T-12R88

*Part of Mallory Type VP-552 Vibrapack

2.56 Switches

SYMBOL	COMPONENT	MANUFACTURER	TYPE
SW-1	Trans CW - Recv	H & H	SPST Toggle, Nickel Plated with short shank
SW-2	Microphone Push-to-talk	Built in microphone	
SW-101	B-F Oscillator On-Off	H & H	DPST Toggle, Nickel Plated with short shank
SW-201	Transmitter On-Off	H & H	SPST Toggle,Nickel Plated with short shank
SW-202	Receiver On-Off	H & H	DPST Toggle, Nickel Plated with short shank

SYMBOL	COMPONENT	MANUFACTURER	TYPE	
SW-203	Transmitter Power Supply Voltage Selector	Mallory	B-110755-1*	
SW-301	Transmitter Meter Switch	(H & H	DPDT Toggle,Nickel Plated,short shank	Note 1
		(Mallory	S-3	Note 2

* Part of Mallory Type VP-552 Vibrapack

2.57 Terminal Strips

SYMBOL	COMPONENT	MANUFACTURER	TYPE
TS-201	Transmitter Power Supply	Mallory	A-40922-1*

*Part of Mallory Type VP-552 Vibrapack

QUANTITY	SYMBOL	COMPONENT	MANUFACTURER	TYPE
2	Vibrapack	Power Supplies, Vibrator, for Transmitter	Mallory	VP-552

Note: Each power supply includes parts marked * in this parts List.

QUANTITY	SYMBOL	COMPONENT	MANUFACTURER	TYPE
2		Vibrators, one for each transmitter power supply.	Mallory	725*
1		Vibrator, Receiver Power Supply	Mallory	725

*Part of Mallory Type VP-552 Vibrapack.

2.59 Miscellaneous

QUANTITY	SYMBOL	COMPONENT	MANUFACTURER	TYPE
1	Micr	Microphone	Kellogg	FS-21C
1		Cord, Microphone	Kellogg	F707
1	P-2	Plug, Microphone	Amphenol	MC4M
1	S-2	Socket, Microphone	Amphenol	PC4F

Note 1: Serial nos. I-46 and lower. See Sec. C13.8, Item 2.71
Note 2: Serial nos. I-47 and higher

QUANTITY	SYMBOL	COMPONENT	MANUFACTURER	TYPE
1		Cable, Battery, 4 feet	Belden	7697
2		Clips, Battery, one marked "+"	Mueller	24A
1	S-1	Socket, Battery Cable, for Transmitter	Jones	S-4-CCT
1	P-1	Plug, Battery Cable, on Transmitter	Jones	P-4-AB 3/4"
1		Cable, Receiver Power, 8" rubber-covered flexible 2-conductor	Collier	Ripcord
1	S-3	Socket, Receiver Power Cable	Jones	S-2-FHE
1	P-3	Plug, Receiver Power Cable, on Receiver	Jones	P-2-AB 1/16"
1	J-1	Jack, Key Cord	Mallory	704A
1	J-101	Jack, Headphones	Mallory	702
1	Crystal	Crystal, Low Temperature Coefficient	Radio Speci- alty	A
1		Holder, Crystal	Radio Speci- alty	A
1		Milliammeter, 0-10 ma with 0-100 ma scale	Triplett	Model 221
1	Relay-1	Relay, 6-V d-c winding	Leach	1027
1	Relay-201	Relay, 6-V d-c winding	Leach	1027
2		Sockets, Vibrator, one for each Transmitter Power Supply	Mallory	A-40921-1*
1	Speaker	Speaker, 5" permanent-magnet dynamic	Jensen	PM-5-DS
1		Key, Telegraph	Signal	112-K
1		Cord, Key, 3-feet, 2-conductor, flexible rubber covered	Collier	Ripcord
1		Plug, Key Cord	Mallory	75

QUANTITY	SYMBOL	COMPONENT	MANUFACTURER	TYPE
1		Headphones	Trimm	F-100
1		Plug, Headphones Cord	Mallory	75TC
1		Dial, Receiver Tuning	National	BM-2
9		Sockets, Octal	Amphenol	MIP-8
1		Socket, 5-prong	Amphenol	RSS-5
1		Socket, 5-prong	Cinch	Y-16
5		Shield, Tube	Bud	391
2		Knobs	Bud	750
1		Socket, Pilot Light, Transmitter	ARHCo	1722
1		Socket, Pilot Light, Receiver	ARHCo	1724
2		Lamps, Pilot	General Electric	Mazda 51
1		Lamp Cap, Transmitter Pilot Light	Western Electric	4F
1		Lamp Cap, Receiver Pilot Light	Western Electric	2L
2		Posts, Binding	X-L	"ANT" Push Post
1		Socket, Receiver Power Supply	Mallory	A-40921-1
2		Buttons, Plug, for Transmitter Panel	Cinch	50628
1		Tie Point, 1 Terminal	Cinch	1516
2		Tie Points, 1 Terminal	Cinch	1510
7		Tie Points, 2 Terminals	Cinch	1520
6		Tie Points, 3 Terminals	Cinch	1530
2		Tie Points, 4 Terminals	Cinch	1540A
17		Grommets	ARHCo	1114
6		Grommets	ARHCo	1115

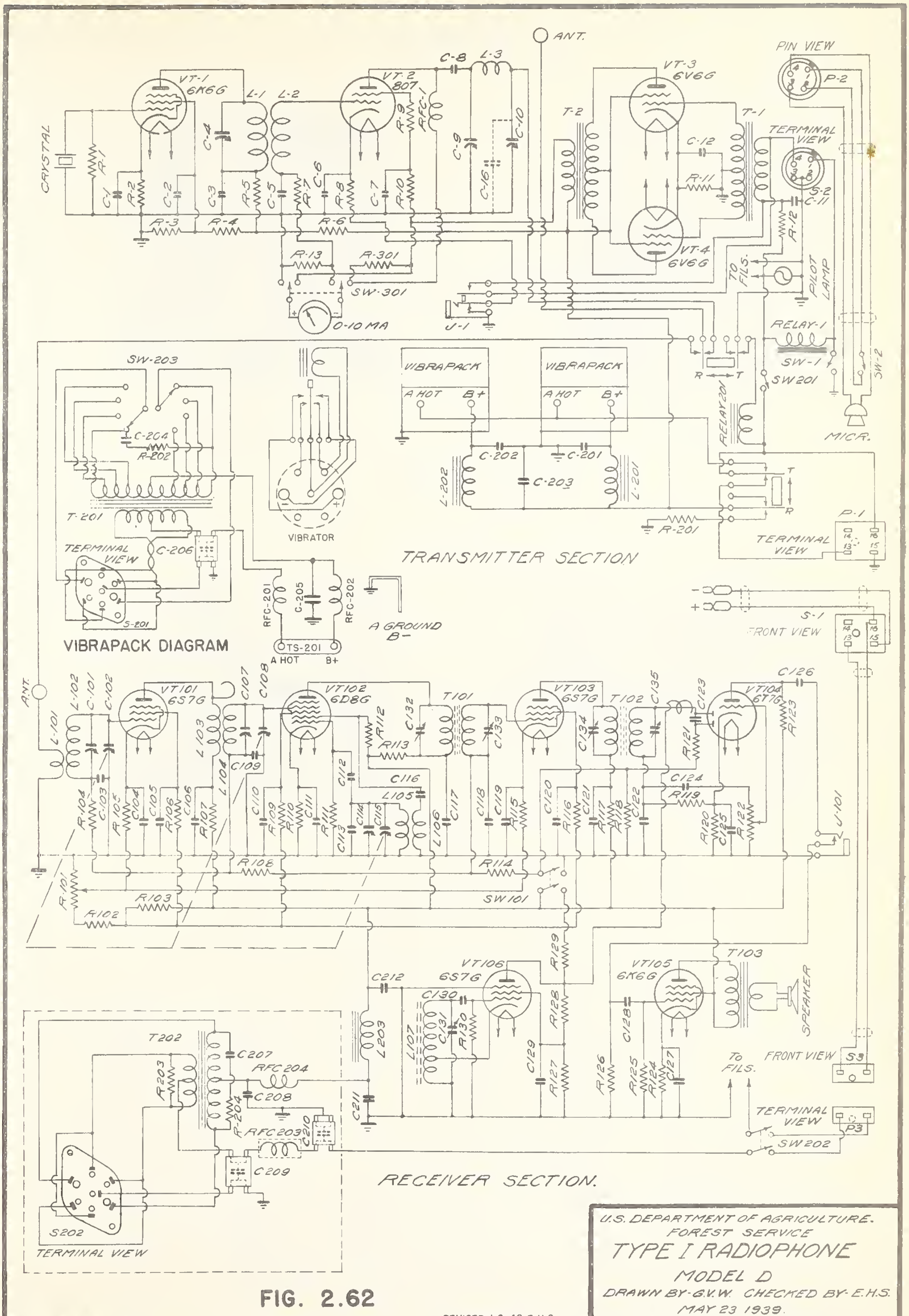
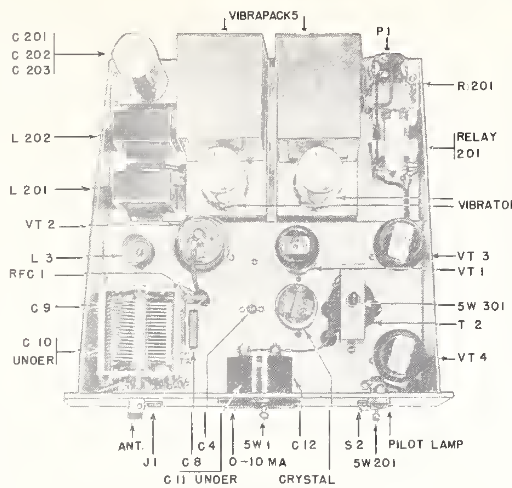


FIG. 2.62

USFS RADIO LAB DRWG I-D-21-B

FIG. 2.63



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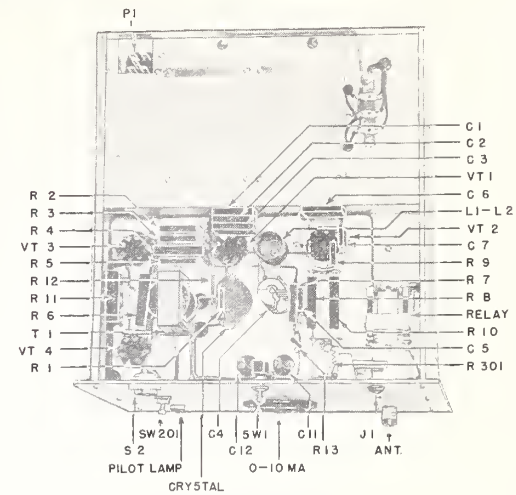

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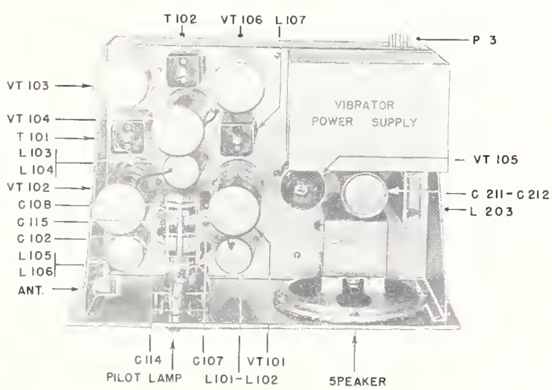
TRANSMITTER SECTION



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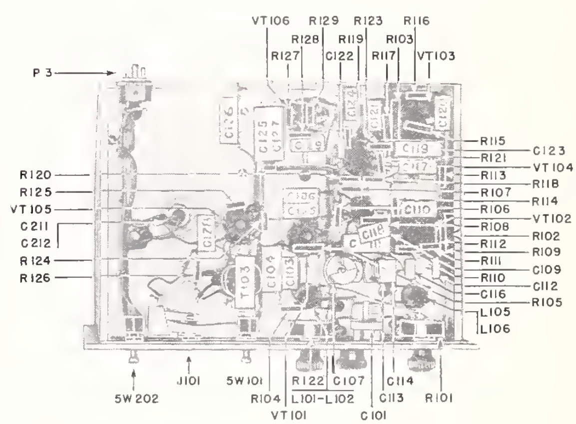

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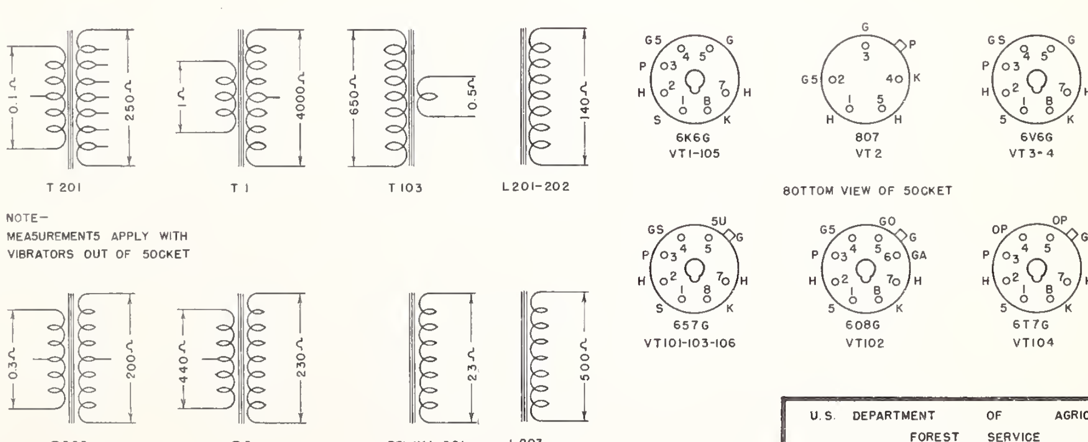
RECEIVER SECTION



U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE I RADIOPHONE MODEL D

PREPARED BY G.V.W. CHECKED BY E.H.S.
JUNE 27 1939

Radio Hdbk.
Added 1-10-40
No. 3

2.7 ADDITIONAL DATA

2.71 Resistance in Meter Switches

A single milliammeter is used to indicate final-amplifier grid and plate currents. Meter switching has been provided by the small toggle switch SW-301 mounted over the modulation transformer.

These switches have shown a tendency to develop internal resistance, with the result that indicated plate current may be less than actual plate current. Sometimes the switch resistance is erratic, and the meter reading can be made to vary by manipulating the switch a few times. In other cases it is necessary to solder temporary jumpers around the switch contacts to detect the error. While such jumpers are in place, the switch should be left in the "PLATE" position, because throwing it to the "GRID" position will result in shorting of the plate supply.

Defective switches should be replaced. Where there are facilities for making slight mechanical changes in the mounting arrangement, a positive-indexing slide switch such as the Mallory S-3 is recommended for replacement. This type meter switch is supplied in serial numbers I-47 and higher.

C13.9 Service Data Sheets

Type K

Model A Nos. I-21 to I-39 Inc.

Model AA Nos. 40 to Inc.

Note: For installation instructions, see "Instructions for Installing", furnished with Radiophone.

Radio Hbk.
Added 11-10-39
No. 2

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0.0 General Description

The Type K Model A Radiophone was formerly known as the Type I, Model B (Mobile).

The Type K Model A Radiophone is intended for use on Forest Service cars and trucks. Both transmitter and receiver may be operated while the vehicle is in motion. Voice signals only are transmitted over a rated distance of approximately 25 miles. The crystal-controlled transmitter operates on one of the frequencies assigned to the Forest Service between 2900 to 3500 kc. The microphone has a "push-to-talk" button, similar to that on the Type M. Although rated power output is 9 watts, the fact that a short antenna is necessarily used reduces the effectiveness of the transmitter below what would normally be expected with the larger half-wave antenna which may be used in non-mobile installations. The Radiophone takes its power from the vehicle storage battery.

The receiver is a commercial superheterodyne, and receives voice signals only in the range 2900 to 3500 kc. Manual controls are mounted on the dash or steering column. In addition, stations on six pre-determined frequencies may be tuned in automatically by use of push buttons mounted on the dash.

The antenna is a vertical semi-flexible fishpole, approximately 8 feet long. It rests on top of its tuning box, which is normally mounted on a front fender. The antenna requires slightly less than 11 feet road clearance.

To facilitate mounting the Radiophone in the space available on a car, the set is supplied in 4 units, each housed in a rugged sheet-metal cabinet. Cables for inter-connecting the units are supplied. These units are:

(1) Transmitter, usually mounted on rear of fire wall, on right-hand side of cab.

(2) Transmitter power supply, usually mounted on front of fire wall (under hood) on right-hand side of car.

(3) Receiver, usually mounted on rear of fire wall, on left-hand side of cab above steering column.

(4) Antenna and antenna-tuning unit, usually mounted on left front fender, just forward of door.

0.1 Electrical Specifications

Frequency Range, Transmitter	One specific frequency assigned to Forest Service between 2900 and 3500 kc.
Frequency Control	Crystal
Type of Signal	Voice
Distance Range	25 (consistent) to 250 miles (occasional)
Power Source	Vehicle Storage Battery
Power Output	9 Watts
Antenna	Vertical fishpole
Tube Complement, Transmitter	1 Type 6K6G Oscillator 1 Type 807 Final Amplifier 2 Type 6V6G Modulators
Frequency Range, Receiver	2900 to 3500 kc.
Tuning control, Receiver	Manual and push button
Tube Complement, Receiver	See Manufacturer's Data
Input	Hand Microphone
Output	Speaker

0.2 Physical Specifications

Table 1 lists overall dimensions of the units of the Radiophone.

Table 1

Unit	Height	Width	Depth
Transmitter	7-3/4"	12-1/4"	7-3/4"
Power Supply	6-1/4"	9-3/4"	6-1/2"
Antenna Tuning Box (Antenna Removed)	9"	7"	6-9/16"
Receiver (Control Cables Removed)	8"	12-1/2"	7-1/2"
Antenna	8'-6"		

Table 2 lists weights of the units of the Radiophone.

Table 2

Unit	Weight
Transmitter, with Microphone and Microphone Cord	15 lbs. 14 oz.
Power Supply, with cable	21 " 10 "
Antenna Tuning Box with Transmission Line and Antenna	4 " 14 "
Receiver, with Controls and Cables	25 " 4 "

1.0 Detailed Description

As noted above, the Radiophone is supplied in 4 units, which are inter-connected with cables. The transmitter unit contains the radio-frequency and modulator sections of the transmitter. The power-supply unit contains the high-voltage power supply for the transmitter only. The receiver has its self-contained power supply.

Physical arrangements of transmitter and power-supply units are shown on Fig. 2.63, the Photodiagram. Components may be identified by reference to 2.5, Parts List, and Fig. 2.62, the Schematic Diagram.

1.1 Transmitter Circuit

A Type 6K6G crystal oscillator excites a Type 807 final amplifier. The modulator consists of a pair of Type 6V6G tubes, operating class AB. Grids of the modulator tubes are driven directly from the secondary of microphone transformer T-1, thus eliminating the need for an intermediate speech amplifier.

Referring to Fig. 2.62, the Schematic Diagram, R-1 is the oscillator grid leak, and L-1, C-4 form the oscillator plate tank, R-f voltage induced in L-2 excites VT-2, the final amplifier. Grid bias for VT-2 is derived from both grid leak R-7 and cathode bias resistor R-8. The cathode bias resistor serves to limit off-resonance plate current during tuning operations. R-9 is a parasitic suppressor, and R-10 a screen-dropping resistor.

The panel meter may be used to indicate either grid current or plate current in the final amplifier, the selection being made by means of a small toggle switch SW-1 mounted inside the cabinet over the modulation transformer T-2. Meter ranges are 0-10 ma for grid current, and 0-100 ma for plate current. After installation the switch is left so that the meter indicates plate current. R-11 is the 100-ma shunt for

plate current. R-12 provides a return path for grid current when panel meter is switched to measure plate current, and has sufficiently high resistance to prevent objectionable shunting action on the meter.

C-8 is a blocking capacitor which prevents final-amplifier plate voltage from reaching the final-amplifier plate coil or the antenna. L-3, C-9, C-10, and C-16 form the final-amplifier plate tank circuit. The arrangement of these elements is such that a pi-section impedance-matching network is obtained, with the result that the low impedance of the antenna transmission line is transformed to a higher impedance, thereby loading the final amplifier properly.

Referring to the audio section of the transmitter, the microphone is connected through its cord in series with the primary of microphone transformer T-1, current limiting resistor R-14, and the battery. A-f currents are bypassed around R-14 and the battery by capacitor C-11. Induced secondary voltage in T-1 is applied to grids of modulators VT-3 and VT-4. Cathode bias resistor R-13, bypassed by C-12, provides grid bias for modulators VT-3 and VT-4. Plates of VT-3 and VT-4 energize the primary of modulation transformer T-2. Plate and screen voltage is supplied to final amplifier VT-2 in series with the secondary of modulation transformer T-2. The a-f voltage produced in the secondary of T-2 by the modulator is in series with the d-c plate and screen voltage. This results in plate modulation of final amplifier VT-2.

1.2 Receiver Circuit

The receiver is a commercial superheterodyne manufactured by Galvin Mfg. Corp. of Chicago, and is identified as the "Motorola Forest Ranger, Type F-68-63". The construction is similar to that of the automobile broadcast receiver known as the "Motorola 8-60", with the exception that the r-f circuits have been re-designed for reception of Forest Service frequencies.

For diagrams, installation notes, and service information see "1938 Motorola Service Manual". The technician who may find it necessary to service one of these receivers should obtain a copy of the above "Service Manual" and file it in Section C13.9 of his Radio Handbook. Address requests for this manual to Regional Forester, Portland, Oregon.

1.3 Power Supply Circuit

Filaments of all tubes are heated directly from the battery. Transmitter plate supply is obtained from the Power Supply Unit. Receiver power supply is an integral part of the receiver. For information concerning receiver power supply, see "1938 Motorola Service Manual", referred to in "1.2, Receiver Circuit".

The Transmitter Power Supply Unit contains 2 vibrator-type plate-supply units and a filter. Referring to Fig. 2.62, the Schematic Diagram, it is seen that primary voltage is supplied to the vibrators through contacts on Relay-201. Vibrator outputs are connected in parallel through their respective filter chokes, L-201 and L-202, C-201, C-202, and C-203 are filter capacitors.

Battery drains are listed in Table 3.

Table 3
Battery Drains

Receiver Operating	6 Amperes
Receiver Operating and Tuning Mechanism Operating	16 Amperes
Transmitter, Filaments only	2.5 Amperes
Transmitter Operating	14 to 15 Amperes (Varies with Modulation)

1.4 Switching Circuits

Referring to Fig. 2.62, the Schematic Diagram, it is seen that "ON-OFF" switch SW-2 interrupts the 6-volt power supplied to the transmitter for filaments, microphone, and for energizing Relay-1, the Send-Receive relay.

The winding of Relay-1, the Send-Receive relay, is connected in series with the 6-volt supply and contacts in the microphone "push-to-talk" switch SW-3. With Relay-1 energized, its contacts perform the following circuit functions:

(a) Ungrounded conductor of antenna transmission line is switched from receiver to transmitter.

(b) Circuit of speaker voice coil is opened, so that receiver is silenced while transmitter is operating.

(c) Winding of Relay-201, in the Power Supply Unit, is energized.

With power-supply relay-201 energized, 6-volt power is applied to the vibrator units. When this relay is de-energized, load resistor R-201 is connected across the output of the power-supply filter to discharge the filter capacitors quickly. This rapid discharge is necessary to prevent the transmitter from continuing operation from energy stored in the capacitors, for a period of seconds after the microphone "push-to-talk" switch has been released. Such prolonged transmitter operation would cause objectionable noise in the receiver.

For receiver switching circuits, see "1938 Motorola Service Manual", referred to in "1.2, Receiver Circuits".

1.5 Other Features

1.51 Antenna

The antenna, antenna matching unit, and transmission line for this radiophone are described in Sec. C9.104, "Mobile Antennas, 3000 kc".

2.0 Adjustment and Repair, General

The following tools and equipment are needed for repair and adjustment of the Type K, Model A Radiophone:

(a) Usual complement of bench and hand tools.

(b) Tube checker.

(c) High-resistance d-c voltmeter, 1000 or more ohms per volt. Scales needed: 0-10, 0-250, 0-1000 volts.

(d) A-c voltmeter, copper-oxide-rectifier type, 1000 ohms per volt. Scales needed: 0-2.5, 0-10, 0-50, 0-250, 0-1000 volts.

(e) Ohmmeter.

Note: Items (c), (d) and (e) may be obtained in a single combination instrument.

(f) Cathode-ray oscilloscope.

(g) Signal generator, with range 2900 to 3500 kc, and also 262 kc.

(h) Audio power output meter. The 0-2.5 volt a-c range of item (d) may be used in place of item (h).

(i) USFS Type A Test Set.

If the Radiophone fails to operate, the following procedure should be used to locate the trouble:

(1) See that cable terminals engage firmly in their receptacles, and that connections on power-supply terminal strip are tight. See that lugs are well separated from each other, and from heads of screws which hold the terminal strip.

(2) See that storage battery is well charged. A hydrometer will indicate a specific gravity of 1.280 for a fully charged battery, 1.250 for a half charge, and 1.220 for a discharged battery.

(3) Check voltage at the "A HOT" terminal on the power-supply terminal strip. Measurement should be made with both receiver and transmitter turned on, and with "push-to-talk" switch pressed. Voltage should be at least 5.7 volts with vehicle motor shut down. If it is less than this amount, voltage should also be measured at the terminals of the battery, with the same load. This will indicate whether the cause of the abnormally low voltage is the condition of the battery, or excessive drop in battery leads and connections. Inspect ground connections. Make necessary repairs or replacements to restore normal voltage at "A HOT" terminal on power-supply terminal strip.

(4) If battery voltage is normal, yet receiver lacks volume and transmitter does not communicate over its usual distance range, check antenna tuning box adjustment. Drive the vehicle into a clear area, at least 20 feet from a building or tree. Tune the receiver to the transmitter frequency, preferably by tuning in a weak signal from another transmitter on the same frequency. Turn knobs associated with tuning push buttons to "COUNTRY" and "VOICE", and turn volume knob all the way to the right. Remove hex cover cap from the capacitor control on the tuning box. See that the antenna is in its normal position, and that door is closed so that all large surfaces have the same relative position with respect to the antenna which they occupy during normal operation. Crouching at arm's length from the tuning box, to minimize capacitance between the antenna and your body, tune screwdriver adjustment on tuning box capacitor for maximum noise output from the receiver. Replace hex cover cap.

2.1 Transmitter Data

If the transmitter fails to operate properly, make the tests outlined in "2.0 Adjustment and Repair, General". If this fails to clear the trouble, the next step is a series of tests which will indicate whether the trouble is in the power supply, r-f section, modulator, or antenna. Having thus localized the trouble, the search for faulty components may be concentrated within the section which is not performing properly.

2.11 Preliminary Tests to Localize Trouble

(1) Turn "ON-OFF" switch SW-2 "ON", and allow 30 seconds for filaments to heat. Press microphone switch SW-3, and note by listening whether power-supply relay (Relay-201) operates. If this relay does not operate, note whether transmitter Send-Receive relay (Relay-1) operates. Failure of relay operation may be caused by mechanical faults on the relay, or by faults in the circuits associated with relay coils. These circuits include wiring, power cable, contacts on Relay-1, the microphone cord, and the microphone switch SW-3.

Note whether the power supply produces any unusual noise. Normally the hum is barely audible, and a louder sound indicates power-supply overload. Do not permit sustained overload.

(2) If power-supply Relay-201 operates, and power-supply unit is relatively quiet, press microphone switch SW-3 and measure voltage between ground and "B + " terminal on power-supply terminal strip. If this voltage is substantially less than 300 volts, remove wire from "B + " terminal, connect a 2000-ohm 50-watt resistor from the "B + " terminal to ground, and again measure voltage. If no 50-watt resistor is at hand, a 10-watt resistor may be used, provided the measurement is made quickly so the resistor does not overheat. If the voltage is still much less than 300 volts, search for trouble in the power-supply unit, as outlined in "2.3 Power Supply Data". However, if substitution of the 2000-ohm resistor for the wire to the transmitter restores "B +" voltage from an abnormally low value to about 300 volts, a fault is indicated in the transmitter or the transmitter power cable. Possible transmitter faults

which may cause an excessive load on the plate supply are ruptured capacitors and breakdown of insulation in wiring or modulation transformer T-2.

(3) If the power supply produces normal voltage with the transmitter load, press microphone switch SW-3 and note reading on transmitter panel meter. When switched to measure plate current, meter range is 0-100 ma. Vary adjustment of "R" control, and note whether plate current dips as "R" is tuned through resonance, and note off-resonance plate current. Plate current at resonance should be 40-50 ma, and off resonance about 65 ma. Failure of plate current to dip through resonance suggests that the oscillator is not operating. If plate current dips through resonance, yet off-resonance plate current is abnormally low, the oscillator may not be operating properly, or a new final-amplifier tube (VT-2) may be needed. However, if plate current dips through resonance and loads to 50 ma or less, and if off-resonance plate current is approximately correct, the r-f portion of the transmitter may be assumed to be operating properly.

(4) With transmitter resonated and loaded to 40-50 ma, the technician should bring his hand into proximity of the antenna while watching the panel meter. If this action causes variation in meter indication, r-f energy is probably being supplied to the antenna satisfactorily. If this action produces no variation in meter indication, trouble is indicated in the transmission line or the antenna tuning box.

(5) If preceding tests have indicated normal conditions, it may be assumed that a carrier is being radiated, and the next step is to test for modulation. This may be done conveniently with a Type A Test Set. See Sec. C12.301, "Type A Test Set", Item 2.04. If no Type A Test Set is at hand, a radio receiver may be used. The receiver should be located far enough from the transmitter so that overloading in receiver circuits is avoided.

If this test is not possible because of lack of equipment, the test of following paragraph (9) will show whether the modulator is performing.

(6) Remove the transmitter from its cabinet. This is done by removing the power-cable plug and the two antenna plugs, and unscrewing the four thumb screws on the panel. Carefully slide the transmitter out. Inspect the transmitter for apparent damage. Work the crystal and each tube in and out of its socket a few times to brighten the contacts. See that the crystal is inserted so that the "GRID" pin engages the ungrounded socket terminal.

(7) Set the transmitter on a suitable support so that the panel is in view, and the under side of the chassis is accessible. Replace power cord and antenna plugs. Turn "ON-OFF" switch SW-2 "ON", and, after allowing 30 seconds for filaments to heat, alternately press and release microphone switch SW-3. Note whether relay action is rapid and positive. See that contacts engage firmly, and that they are in good condition. If it is necessary to dress these contacts, this should be done with the utmost care to insure that they will contact over their full surfaces. A suitable method is to fold a piece of crocus cloth so that the abrasive surface of the cloth is on the outside. Insert the folded cloth between the contacts, press the contacts together, and pull the cloth out.

Repeat several times, thereby brightening the contact surfaces. In cases of severe contact pitting it may be necessary to use folded fine emery cloth before securing the final surface with crocus cloth.

(8) Turn meter switch SW-1, which is mounted over the modulation transformer T-2, to "GRID". When switched to measure grid current, meter range is 0-10 ma. Press microphone switch SW-3, and note meter reading. A normal reading of from 2 to 4 ma indicates that the oscillator is operating. Return meter switch SW-1 to "PLATE".

(9) Modulator performance may be checked by measuring the a-f voltage induced in the secondary of the modulation transformer. Connect the prods of a copper-oxide- rectifier a-c voltmeter across the secondary of modulation transformer T-2. A blocking capacitor may be inserted in series with the voltmeter to eliminate the slight deflection caused by d-c drop in the winding. Switch the voltmeter to the 1000-volt scale, press microphone switch SW-3, and whistle into the microphone. The actual deflection observed will depend upon final-amplifier loading and the intensity of the sound input to the microphone. A typical deflection will be about 225 volts.

(10) If all of the foregoing checks indicate normal conditions, it is probable that the transmitter is performing properly. If trouble is indicated in the r-f section, the modulator, or the power supply, the search for the faulty condition should follow the procedure outlined below under the appropriate heading. See "2.12 R-F Section, Adjustment and Repair", "2.13 Modulator, Adjustment and Repair", and "2.30 Power Supply Data".

2.12 R-F Section, Adjustment and Repair

(11) Measure tube-element voltages. See tube- socket diagrams on Fig. 2.63, the Photodiagram. All filaments should have the full battery voltage applied to their terminals, and this should not decrease greatly when the microphone switch is pressed. Normal voltages of other elements should be appoximately as listed in Table 4. Screen and cathode voltages on oscillator VT-1 and final amplifier VT-2 will be somewhat dependent upon adjustments, the values shown being normal for correct adjustment.

Table 4

Normal Tube-Element Voltages (Measured to Ground)

(a) VT-1 Oscillator (Type 6K6G)	
Plate Supply (Junction of R-5 and R-6)	240 to 225*
Screen	120 to 115*
Cathode Bias	Depends upon adjustment of C-4 and resulting plate current. Typical Value, 12 volts.
(b) VT-2 Final Amplifier (Type 807)	
Plate (Measured on meter side of RFC-1)	290 to 270*
Screen	205 to 185*
Cathode Bias	Depends upon loading and resulting plate current. Typical value, 18 volts.
(c) VT-3 and VT-4 Modulators (Types 6V6G)	
Plates and Screens	305 to 295*
Cathode Bias	19 to 26*

*Varies with modulation.

(12) The next step is the re-tuning of the oscillator. See that the crystal is inserted so that the "GRID" pin engages the ungrounded terminal on the crystal socket. Turn meter switch SW-1 to "GRID", for which position the panel meter range is 0-10 ma. Switch the d-c voltmeter to the 10-volt scale and connect prods across R-5 (see Fig. 2.62, Schematic Diagram, and Fig. 2.63, Photodiagram). R-5 carries the oscillator plate current, and since its value is 1000 ohms, voltage drop across R-5, as indicated by the voltmeter, is equal to the oscillator plate milliamperes. Turn oscillator plate capacitor C-4 to maximum capacitance. Press microphone switch SW-3, and slowly reduce the capacitance of C-4, watching both final-amplifier grid current and oscillator plate current, as indicated by panel meter and external voltmeter, respectively. Oscillator plate current will dip sharply about the same time final-amplifier grid current starts. Continue to reduce capacitance of C-4 until final-amplifier grid current is maximum. If C-4 is turned past this point, it is not permissible to make a slight re-adjustment of C-4 in the reverse direction. C-4 should be returned to maximum capacitance, and the procedure repeated. After making this adjustment, alternately press and release the microphone switch several times to make sure the oscillator starts reliably. If there is a tendency toward unreliable starting, inspect crystal and crystal holder. Clean crystal, and see that holder does not bind edges of crystal. Return meter switch SW-1 to "PLATE".

(13) The next step is the adjustment of "R" and "L" controls for proper loading and for resonance in the final-amplifier plate circuit. To make this adjustment, see that meter switch SW-1 is turned to "PLATE", for which position it will have a range of 0-100 ma. Press microphone switch SW-3, and tune "R" adjustment for minimum final-amplifier plate current, as indicated by panel meter.

If this minimum current is less than 40-50 ma, turn "L" control so as to reduce capacitance of C-10, and again tune "R" for minimum panel-meter indication; if more than 40-50 ma, turn "L" control so as to increase C-10 capacitance, and repeat adjustment of "R" control for minimum panel-meter indication. This series of alternate adjustment of "L" and "R" controls is repeated until panel meter indicates 40-50 ma when "R" is tuned for minimum current. The adjustment of the "R" control is the last adjustment made.

(14) Detune only the "R" control, and observe maximum off-resonance plate current. If this current is less than about 65 ma, the need for a new final-amplifier tube is indicated. This of course presupposes that all previous checks on plate voltage and excitation have been made. Retune "R" control for minimum plate current.

(15) It may be observed that there is no setting of the "L" control which will result in an indication of 40-50 ma when the "R" control is adjusted for minimum plate current. This situation may be the result of an improper condition in the antenna matching unit, or of an incorrect value of capacitance for loading capacitor padder C-16. If this difficulty is experienced, first inspect the interior of the antenna tuning box. See that connections are soldered firmly, and that no turn is short-circuited. Make sure the box is free from excess moisture and foreign bodies. Check tuning-box adjustment as outlined in "2.0, Adjustment and Repair, General", paragraph (4). If this does not clear the trouble, the capacitance of loading capacitor padder C-16 may need to be changed. If the minimum plate current loading obtainable by adjustment of "L" and "R" controls exceeds 40-50 ma, capacitance of C-16 should be increased; if maximum loading is less than 40-50 ma, C-16 should be decreased. Although trial adjustments may be made with any good mica capacitors at hand, the capacitor finally installed should have a rating of 1000 working volts (2500 d-c volts test). A Cornell-Dubilier Type 4 or an Aerovox Type 1456 is satisfactory.

(16) Turn meter switch SW-1 to "GRID". Press microphone switch and note final-amplifier grid current. This should be between 2 and 4 ma. Return meter switch to "PLATE".

(17) If the initial adjustment of the transmitter was poor, it will be well to re-check tube-element voltages with Table 4.

(18) Before replacing transmitter in its cabinet, make sure meter switch SW-1 has been returned to "PLATE".

2.13 Modulator, Adjustment and Repair

(19) If the foregoing tests of paragraphs (5) or (9) indicate improper modulator performance, the first step is the checking of modulator-tube voltages. See Table 4.

(20) Examine microphone and microphone cable for physical damage. Make continuity tests between pins on microphone plug P-2 to determine if wires are open. Flex the cable while making this test to detect intermittent

opens in the wires. There may be some minor variation in individual cables concerning whether the common (ground) wire in the cable is connected to pin #2, pin #3, or to both; this will make no difference in performance, since pins #2 and #3 are both grounded on receptable S-2. Results of continuity tests should be as shown in Table 5.

Table 5

Normal Resistances Between Pins on Microphone Plug

Continuity between Pins	Resistance, Micr. Button Released	Resistance, Micr. Button Pressed
Common and Pin #1	Open	0
Common and Pin #4	Open	50 to 150 ohms
All Pins to Shell	Open	Open

(21) If the foregoing tests have not cleared the trouble, voltages across winding of microphone transformer T-1 and modulation transformer T-2 should be measured with a copper-oxide-rectifier type a-c voltmeter, while the technician or an assistant whistles into the microphone. Observed voltage will depend somewhat on the intensity of the sound directed into the microphone and upon final-amplifier loading. Typical values are listed in Table 6.

Table 6

Typical A-F Voltages across Windings of Microphone and Modulation Transformers

T-1 Primary	0.25 volt
T-1 Secondary	Meter barely deflects on 50-volt scale, due to meter loading on transformer.
T-2 Primary	400 volts
T-2 Secondary	225 volts

The presence or absence of normal voltages on the different windings will indicate the general location of the faulty component. Possible faults may include weak tubes, shorted or grounded transformer windings, and grounds or opens in the wiring. Transformer resistances may be compared with values given on Fig. 2.63, the Photodiagram.

(22) At the conclusion of repairs, the modulation should be checked, preferably with an **Oscilloscope**. Using the directions of Sec. C12.402, "R-F Pick-up Device for Oscilloscope", adjust controls on oscilloscope for viewing modulated carrier in screen. Note whether modulation is complete for normal speech into the microphone, and whether there is evidence of serious distortion. If no oscilloscope is on hand, an audible check of the modulation may be made by use of the Type A Test Set. See Sec. C12.301, "Type A Test Set", Item 2.04.

(23) In replacing the transmitter in its cabinet, see that meter switch SW-1 is turned to "PLATE".

2.2 Receiver Data

If the receiver fails to function, make the tests outlined under "2.0 Adjustment and Repair, General". If this fails to clear the trouble, see that Relay-1, the send-receive relay in the transmitter, is functioning properly. When this relay is released, voice-coil circuit is completed to ground, and the antenna is switched to the receiver.

For further information, see "1938 Motorola Service Manual", referred to in "1.2 Receiver Circuit".

2.3 Power Supply Data

If the test outlined in "2.1 Transmitter Data", paragraph (2), shows that the power supply is defective, the following procedure should be used to locate the trouble:

(1) Remove connections from "B+ " and "RELAY" terminals on terminal strip. Remove cover plate from cabinet.

(2) Each vibrator can be inserted into its socket in either of two ways. See that each vibrator is so inserted that the "+" or "-" sign at the top of the vibrator which is toward the outside of the cabinet corresponds with the ungrounded battery terminal.

(3) Alternately connect and disconnect ground to "RELAY" terminal. Note whether relay action is rapid and positive. See that contacts engage firmly, and that they are in good condition. If it is necessary to dress these contacts, use the method outlined in "2.1 Transmitter Data", paragraph (5).

(4) Switch voltmeter to the 1000-volt range, and connect prods between ground and the "B+" terminal on the terminal strip. Momentarily operate the relay by connecting ground to the "RELAY" terminal, and note voltmeter reading. Repeat this measurement, first with one vibrator removed from its socket, then with this vibrator replaced in its same socket, and the other vibrator removed. In replacing the vibrator, observe the caution of paragraph (2), above. While testing the vibrators singly, the relay should be operated and released several times to determine whether each vibrator starts reliably, and if there is any tendency for intermittent operation. A barely audible hum should be produced by the vibrator while it is operating.

Normally all three readings should be about 400 volts.

(5) In the above tests using single vibrators, a vibrator may be assumed to be in good order if it starts reliably and produces normal voltage. If low or zero voltage is observed, try substituting a new vibrator, or one known to be in good order. If this clears the trouble, it is necessary to determine whether the vibrator has simply worn out, or if it was damaged by faults in associated circuits.

A worn-out vibrator often exhibits intermittent operation and failure to start. Sometimes a worn-out vibrator which has failed to start may be started by jarring its can. Contacts do not normally tend to stick. Sticking contacts can usually, although not always, be detected by making ohmmeter tests on base pins, referring to Fig. 2.62, the Schematic Diagram. These tests should show an open circuit between all pairs of pins except the pair across which the coil is connected. Coil resistance is approximately 38 ohms.

The foregoing ohmmeter test may fail to reveal sticking contacts, because such sticking contacts may be jarred loose when the vibrator is removed from its socket. If the ohmmeter test did not disclose sticking contacts, connect one 32-candlepower headlamp filament in series with the "A HOT" lead. With only the vibrator inserted in which trouble is being sought, and with load still disconnected momentarily operate the relay. Normally the filament will glow dimly when the relay is first operated, and then will become dark. The vibrator should produce a barely audible hum. If the vibrator fails to start, there will be no momentary glow and no hum. However if the vibrator sticks, the filament will light with nearly full brilliance, and there will be no hum. The relay should be operated and released several times during this test, to provide the vibrator ample opportunity to display any tendency to stick. Obviously, trouble caused by a sticking vibrator should be cleared by substitution of a vibrator known to be in good order.

The only two circuit faults which will damage vibrators are (a) serious overloads from short circuits, and (b) defective buffer capacitors (C-204). If vibrator contacts are short-circuited, or if they tend to stick, it may be assumed that there is circuit trouble which mere replacement of the vibrator will not cure, and the search for faulty components should be continued.

Do not attempt to repair a vibrator. Filing contacts or bending springs destroy the factory adjustment which was made carefully with precise instruments. Do not replace a vibrator unless it is known to be defective.

(6) Unless the foregoing tests have cleared the trouble and have assured the technician that damage to vibrators which may have been replaced was not caused by circuit trouble, remove the power supply unit from the car. Remove cabinet and make visual inspection for physical damage.

(7) See that selector switch SW-201 is on position #4 on both "Vibrapack" units. This switch is mounted on the side of the "vibrapack"chassis.

(8) If any of the tests of paragraph (4) produced normal voltage at the "B+" terminal on the terminal strip, the procedure of this paragraph may be omitted.

Disconnect wires from "B+" terminals on "vibrapacks". Insert a piece of paper between upper contacts on Relay-201 which connect ground to resistor R-201 when the relay is released. With the ohmmeter switched to the highest resistance scale, touch one prod to chassis and the other to one of the free wires which have been disconnected from the "vibrapack" "B+" lead. Due to

the presence of electrolytic filter capacitors C-201, C-202, and C-203, the ohmmeter will show a much higher resistance with prods one way than with prods interchanged. The higher resistance reading should be at least 1 megohm. If the higher reading is much less than this amount, examine filter capacitors C-201, C-202, and C-203 for short circuits. Test filter chokes L-201, and L-202 for grounded windings. Remove paper from relay.

(9) Test filter chokes L-201 and L-202 for continuity. Resistances should be 140 ohms each.

The above procedure will usually, although not always,disclose capacitor short circuits and filter-choke grounds. An existing short or ground which escapes this test will be disclosed in the procedure of following paragraph (13).

(10) Connect leads from a well-charged 6-volt storage battery to "A HOT" and "GND" terminals on the terminal strip. See that battery polarity corresponds with the way the vibrators are inserted, as explained in paragraph (2). With wires still disconnected from "B+" terminals on "vibrapacks", operate the relay and measure battery voltage at the terminal strip, to be sure it is at least 5.7 volts. Measure voltage from chassis to the "B+" terminal on each "vibrapack". While making each measurement, the relay should be alternately operated and released several times to determine if the vibrator starts reliably. Normally each "vibrapack" delivers about 400 volts to its "B+" terminal with no load, assuming the input voltage is a full 6 volts. If one or both "vibrapacks" deliver substantially less than 400 volts, try substituting a new vibrator or one known to be in good order. If this clears the trouble, it is necessary to determine whether the vibrator has simply worn out, or if it was damaged by faults in associated circuits. See discussion in paragraph (5) above. A ground in the filter, as may have been disclosed in the test of paragraph (8), is a possible cause of vibrator damage.

(11) If a sticking vibrator has been replaced, the buffer capacitor C-204 in the associated "vibrapack" should be tested to make sure it is not shorted, open, or of incorrect capacitance. Remove the "vibrapack" from the power-supply chassis and take off the bottom plate. A short-circuit will be evident from the resulting damage to R-202. To test for an open circuit, connect prods of a 0-50 volt copper-oxide-rectifier a-c voltmeter across R-202 and operate relay. Normally the voltmeter will indicate from 12 to 14 volts. An open capacitor will result in zero indication.

Some of the earlier "vibrapacks" were furnished without R-202. This resistor should be installed in such units. Use only a 5000-ohm 1/2-watt resistor, and see that leads are insulated with adequate sleeving. This resistor serves to prevent damage to vibrator and transformer in the event of rupture of buffer capacitor C-204.

If no copper-oxide-rectifier a-c voltmeter is at hand, the presence of either an open or a short in this capacitor may be detected by disconnecting it from the circuit and charging it to about 400 volts from an external source, which may be the other "vibrapack", and noting whether the capacitor gives off a spark when discharged through an external short-circuit. To disconnect capacitor, carefully unsolder the lead between R-202 and the selector switch. The capacitor should be charged in series with R-202, thus avoiding overload on the charging source in case the capacitor is ruptured. The external short circuit for discharging should not include the resistor.

If no spark is observed, make several trials before you decide the capacitor is faulty. In such cramped space it is easy to accidentally discharge the capacitor before getting the external jumper into a position where the spark, if any, may be observed. Further, the spark is feeble, and must be carefully sought to be observed. Replace lead from R-202 on selector switch terminal.

See that marked capacitance on buffer capacitor C-204 is .005 mfd., and voltage rating 1600 volts. It is important that a replacement have this same rating.

(12) If the location of trouble is still in doubt, check all components within the "vibrapack" unit, such as r-f filter capacitors and chokes, transformer, and selector switch SW-201. Check wiring for opens, grounds, or shorts.

(13) When normal no-load voltage of approximately 400 volts has been restored to "B+" terminals on both "vibrapacks", re-connect wires to these terminals. Operate relay, and measure no-load voltage at "B+" terminal on terminal strip. If this measurement shows much less than 400 volts, disconnect filter capacitors C-201, C-202, and C-203, and repeat measurement. If this clears the trouble, replace these three capacitors which are contained in a single case.

(14) At the conclusion of repairs, check voltage at the "B+" terminal on the terminal strip with the 2000-ohm load. This should be approximately 300 volts. This check under load should be made again after the power supply unit is replaced in the vehicle.

2.5 Parts List

2.51 Capacitors

Symbol	Component	Rating	Manufacturer	Type
C-1	Oscillator Cathode Bypass	.004 mfd mica	Aerovox	1460
C-2	Oscillator Screen Bypass	.004 mfd mica	Aerovox	1460
C-3	Oscillator Plate Bypass	.004 mfd mica	Aerovox	1460
C-4	Oscillator Tuning	50 mmf variable	Hammarlund	APC-50
C-5	Final Grid Bypass	.005 mfd mica	(Aerovox (Solar	1467)* MW-1239)
C-6	Final Cathode Bypass	.005 mfd mica	Aerovox	1460
C-7	Final Screen Bypass	.005 mfd mica	(Aerovox (Solar	1467)* MW-1239)
C-8	Final Plate Blocking	.005 mfd mica 1000 WV	(Aerovox (Cornell- (Dubilier	1456)) 4)
C-9	Final Tuning	365 mmf variable	Cardwell	MR-365-BS
C-10	Final Loading	365 mmf variable	Cardwell	MR-365-BS
C-11	Microphone Bypass	10-10 mfd 75V Electrolytic	Mallory	BN-226
C-12	Modulator Cathode Bypass	10-10 mfd 75V Electrolytic	Mallory	BN-226
C-16	Additional Final Loading	As required to match load. For frequencies between 2950 and 3450 kc, about .0005 mfd is needed for matching a 75 ohm load. Use Aerovox Type 1456 or Cornell-Dubilier, Type 4.		
C-201	Ripple Filter	8 mfd 450 WV)	Mallory Solar	CM-175)* LG5-888)
C-202	Ripple Filter	8 mfd 450 WV)		
C-203	Ripple Filter	8 mfd 450 WV)		
C-204	Vibrator Buffer	.005 mfd 1600 V Oil Filled	Mallory	A-40980-1**

* or equivalent
** Part of Mallory Type VP-552 Vibrapack.

Symbol	Component	Rating	Manufacturer	Type
C-205	R-F Filter	.05 mfd 600 V paper	Mallory	TP-415 **
C-206	R-F Filter	.5 mfd 100 V paper	Mallory	RF-481**

2.52 Inductors

Symbol	Component	Description		
L-1	Oscillator Plate	45 turns #28 enameled wire, close-wound on National Type XR-2 Form.		
L-2	Final Grid	18 turns #32 enameled wire, close wound, fitted inside form for L-1.		
L-3	Final Plate	36 turns #22 enameled wire, wound on National Type XR-2 form, threaded 30 turns per inch.		
L-201	Filter Choke	5 Henries 80 ma	Thordarson	T 57 C 51
L-202	Filter Choke	5 Henries 80 ma	Thordarson	T 57 C 51
L-203	R-F Filter		Mallory	RF-583 **
L-204	R-F Filter		Mallory	A-40919-1**
RFC-1	Final Plate Choke	2.5 mh, 125 ma	(Coto (Hammarlund	CI-11) CH-X)

2.53 Resistors

Symbol	Component	Rating	Manufacturer	Type
R-1	Oscillator Grid Leak	50,000 ohms, $\frac{1}{2}$ watt	IRC	BT-$\frac{1}{2}$
R-2	Oscillator Cathode	1,000 " 1 "	IRC	BT-1
R-3	Bleeder	25,000 " 1 "	IRC	BT-1
R-4	Oscillator Screen Dropping	15,000 " 2 "	IRC	BT-2
R-5	Oscillator Plate Return Filter	1,000 " 1 "	IRC	BT-1

* or equivalent
** Part of Mallory Type VP-552 Vibrapack.

2.53 Resistors (Cont'd)

Symbol	Component	Rating	Manufacturer	Type
R-6	Oscillator Plate Dropping	4,000 ohms, 2 watt	IRC	BT-2
R-7	Final Grid Leak	15,000 " 1 "	IRC	BT-1
R-8	Final Cathode	250 " 2 "	IRC	BT-2
R-9	Parasitic Suppressor	50 " ½ "	IRC	BW-½
R-10	Final Screen Dropping	15,000 " 2 "	IRC	BT-2
R-11	Final Plate Meter Shunt	Special		
R-12	Final Grid Meter Shunt	500 ohms, ½ watt	IRC	BT-½
R-13	Modulator Cathode	250 " 10 "	Ohmite	Brown Devil
R-14	Microphone Dropping	100 " ½ "	IRC	BT-½
R-201	Capacitor Discharge Limiting	200 " 10 "	Ohmite	Brown Devil
R-202	Buffer Capacitor Series	5,000 " ½ "	(Mallory (IRC	A-40389-3)** BT-½)

2.54 Tubes

Symbol	Component	Manufacturer	Type
VT-1	Oscillator	Sylvania, RCA	6K6G
VT-2	Final Amplifier	RCA	807
VT-3	Modulator	Sylvania, RCA	6V6G or 6V6
VT-4	Modulator	Sylvania, RCA	6V6G or 6V6

2.55 Transformers

Symbol	Component	Manufacturer	Type
T-1	Microphone	Phelps-Dodge	Inca 06985
T-2	Modulation	Phelps-Dodge	Inca 07021
T-201	Vibrapack Power	Mallory	B-40966-1 **

** Part of Mallory Type VP-552 Vibrapack

2.56 Switches

Symbol	Component	Manufacturer	Type
SW-1	Meter Switch	(H & H (((Mallory	DPDT Toggle, Note 1 with short nickel-plated handle. S-3 Note 2
SW-2	On-Off	H & H	SPST Toggle, with short nickel-plated handle.
SW-3	Microphone "push-to-talk"		Integral with microphone.
SW-201	Vibrapack voltage selector.	Mallory	B-111202-1 **

2.57 Terminal Strips

Symbol	Component	Manufacturer	Type
TS-201	Vibrapack Terminal Strip	Mallory	A-40922-1 **

2.58 Power Supply

Quantity	Component	Manufacturer	Type
2	Vibrapacks	Mallory	VP-552
2	Vibrators	Mallory	725 **

2.59 Miscellaneous

Quantity	Component	Manufacturer	Type
1	Crystal in holder (Specify frequency)	Radio Specialty Sentry	B J2A
1	Microphone	Kellogg	T-17
1	Cord, Microphone, 3-conductor flexible rubber covered, 5 ft.	Belden	8453
1	Socket, Microphone Cord	Amphenol	PC4F

** Part of Mallory Type VP-552 Vibrapack.

Note 1: Serial nos. K-54 and lower. See Sec. C13.9, Item 2.72, p. 27a.
Note 2: Serial nos. K-55 and higher.

2.59 Miscellaneous (Cont'd)

Quantity	Component	Manufacturer	Type
1	Plug, Microphone Cord	Amphenol	MC4M
1	Milliammeter, 0-10 ma	Triplett	Model 221
1	Relay (Relay 1), Send-Receive	Leach	Type 2023 with Coil 354
1	Relay (Relay-201), Power Supply	P & D	HR-4002 Horn Relay
1	Receptacle, Power Cable	Jones	P-6-AB-3/4"
1	Plug, Power Cable	Jones	S-6-CCT
1	Cable, Power, 4-conductor color coded, with braided covering, 5 ft.	(*) Lenz	(4-conductor battery (cable per Lenz shop (order ~~69272~~ 98304, mfd. for (U.S. Dept Agri., F.S.
2	Receptacles, Antenna Connector	Amphenol	PC-1-M
2	Plugs, Antenna Connector	Amphenol	MC-1-F
1	Socket, Pilot Lamp	ARHCo	1539
1	Lamp, Pilot	G. E.	Mazda 51
2	Sockets, Vibrator	Mallory	A-40921-1 **
1	Socket, Crystal Holder, 5-prong	Eby	12B
1	Socket, 5-prong	Amphenol	RS-5
3	Sockets, Octal	Amphenol	MIP-8
1	Lead, Antenna	Supplied with Receiver	
1	Lead, Receiver Voice Coil, #16 flexible braided rubber covered, 8 feet.		
2	Leads, Battery, #8 flexible braided rubber covered, 3 feet, fitted with terminal lugs.	Belden	7708

** Part of Mallory Type VP-552 Vibrapack.

2.59 Miscellaneous (Cont'd)

Quantity	Component	Manufacturer	Type
1	Insulator, stand off support for C-16	National	GS-10
1	Clip, Grid	National	24
1	Shield, Tube	Bud	(*) SH-392
2	Buttons, Plug	Cinch	50660
1	Insulator, stand-off for L-3	Johnson	601

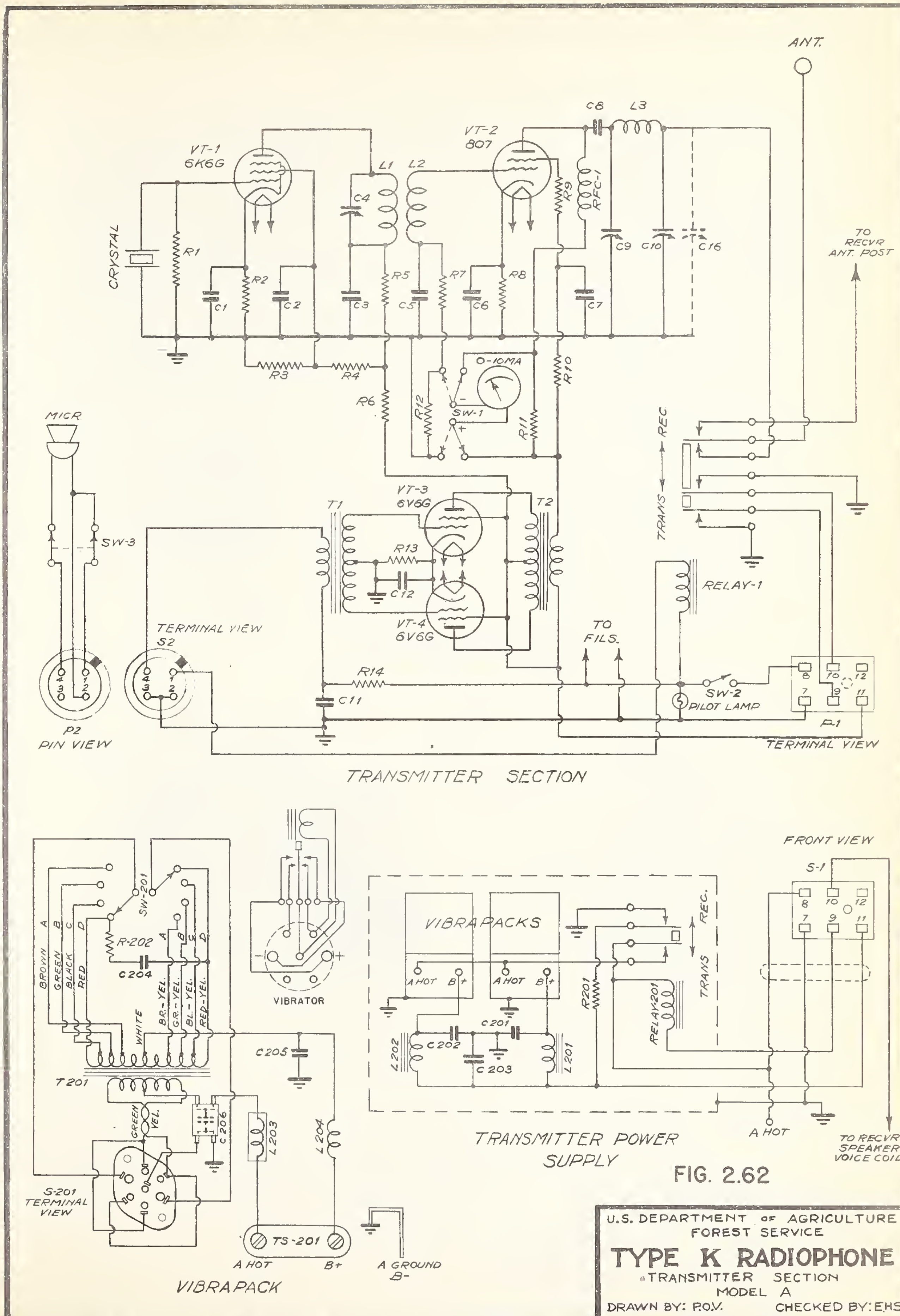


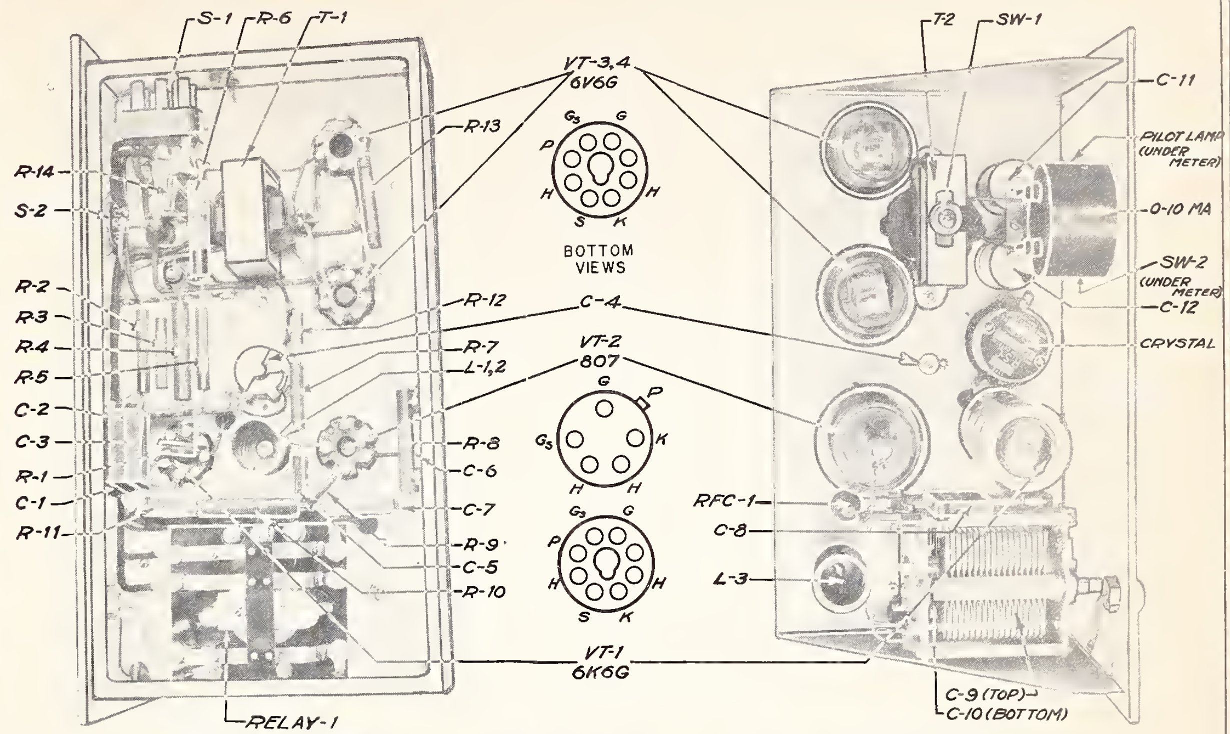
FIG. 2.62

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

TYPE K RADIOPHONE

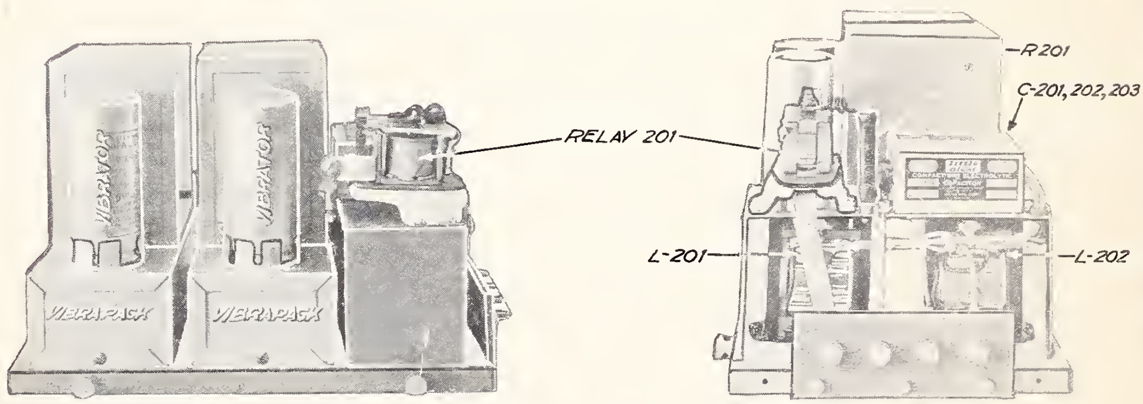
TRANSMITTER SECTION
MODEL A

DRAWN BY: P.O.V. CHECKED BY: E.H.S.
DEC. 1, 1938



BOTTOM VIEW TOP VIEW

TRANSMITTER



SIDE VIEW END VIEW

POWER SUPPLY

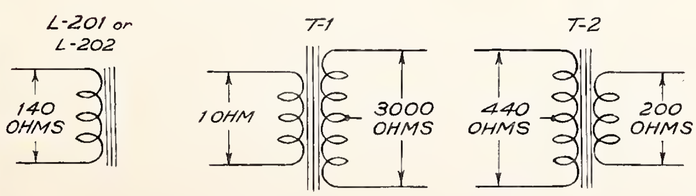


FIG. 2.63

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE K RADIOPHONE
MODEL A
TRANSMITTER SECTION
DRAWN BY: P.O.V. CHECKED BY: E.H.S.
DEC. 2, 1938

2.7 Additional Data

2.71 Antenna Tuning Box, Parts List

The mobile antenna and tuning box supplied with the Type K Radiophone is described in Sec. C9.104 and C9.105. The following Parts List will be helpful in replacing parts of the antenna. Parts-List symbols correspond with those in Sec. C9.104, Fig. 1.

Parts List, Antenna and Tuning Box

Symbol	Component	Rating	Manufacturer	Type
C 17	Capacitor, Resonating	20 mmf variable	Hammarlund	MC-20-SX
L-4 *	Coil, Loading	$38\frac{1}{2}$ turns #18 enameled wire, tapped at 1-7/8 turn, wound 16 turns per inch on Bud Type 734 form, notched for 16-turns-per-inch winding.		
**	Insulator, Lead-through		National	XS-3
	Cabinet, Sheet metal		Special	
	Gland, Packing, for Transmission Line		Special	
	Cap, Cover for C-17 control		Special	
	Line, Transmission, 6 feet, fitted with antenna connector plug as per Type K Parts List.		Bassett	BCF-64-200
	Antenna, Fishpole, fitted with 90 ampere lug.		Horton	Kayo Steel Fishing Rod, No.3309.
	Lug, 90 ampere, to be fitted over lead through insulator for antenna mounting.		General Electric	

* Inductance of loading coil is critical, and should be such that tuned circuit with antenna included, and mounted on car, resonates at operating frequency. With dimensions shown, tuned circuit will resonate to frequencies between 3085 and 3500 kc for most installations. For lower frequencies or for unusual installations number of turns may have to be changed. Do not compensate for inadequate turns with additional capacitance.

** National Type XS-3 ceramic bowls are supplied in pairs, only one of which is needed for the tuning box.

2.72 Resistance of Meter Switch

A single milliammeter is used to indicate final-amplifier grid and plate currents. Meter switching has been provided by the small toggle switch SW-1 mounted over the modulation transformer.

These switches have shown a tendency to develop internal resistance, with the result that indicated plate current may be less than actual plate current. Sometimes the switch resistance is erratic, and the meter reading can be made to vary by manipulating the switch a few times. In other cases it is necessary to solder temporary jumpers around the switch contacts to detect the error. While such jumpers are in place, the switch should be left in the "PLATE" position, because throwing it to the "GRID" position will result in shorting of the plate supply.

Defective switches should be replaced. Where there are facilities for making slight mechanical changes in the mounting arrangement, a positive-indexing slide switch such as the Mallory S-3 is recommended for replacement. This type meter switch is supplied in serial numbers K-55 and higher.

C13.9 Service Data Sheets

Type K

Model AA

#B.56 —

Nos. K-40 to 55 Inc.

Radio Hdbk
Added 6-1-40
No. 7

The Type K Model AA Radiophone transmitter differs from that of the Type K Model A only in certain details. An improvement in the provision for mounting the transmitter and power supply simplifies installation in most vehicles. A better terminal block has been furnished on the power supply.

The receiver is a new commercial superheterodyne manufactured by Galvin Mfg. Corp. of Chicago, and is identified as the "Motorola Police Cruiser", Model P-69-14, with special frequency range of 1.9 to 3.6 Mc. For diagrams, installation notes, and service information see "Installation Instructions, Service Information, Motorola Police Cruiser". The technician who may find it necessary to service one of these receivers may obtain a copy of the above publication from the Regional Forester, Portland, Oregon. It is suggested that this copy be filed in Section C13.9 of his Radio Handbook.

also "Service Manual", Motorola Electric Automatic Tuner"; Galvin Mfg. Co. Form S-7-R.

The Parts List for the Model AA is the same as for the Model A, with the following exceptions:

Symbol	Component	Mfctr.and Type in Model AA	Mfctr.and Type in Model A
C-11	Microphone Bypass	Mallory Type FPD-208 150-V 20-20 mfd. electrolytic capacitor. One section used as C11; one section as C12. (See Note 1)	Mallory Type BN-226* Dual Sections in Parallel
C-12	Modulator Cathode Bypass		Mallory Type BN-226* Dual Sections in Parallel
	Receptacles, Antenna Connector (2 required)	Amphenol Type 80-CT	Amphenol Type PC-1-M
	Plugs, Antenna Connector (2 required)	Amphenol Type 80-MT	Amphenol Type MC-1-F
Relay-1	Relay, Send-Receive	Leach Type 1027 with coil 354, 6 volts. (See Note 2)	Leach Type 2023 with coil 354.
Relay-201	Relay, Power Supply	Leach Type 1027 with coil 354, 6 volts	P & D Type HR-4002 Horn Relay
	Milliammeter, 0-10 ma	Triplett Model 221 0-10 ma with 0-100 scale	Triplett Model 221 0-10 ma with 0-10 scale

Note 1: Serial numbers K-41 and K-42 each have 2 Mallory Type FPD-208 capacitors, one each for C-11 and C-12, with dual sections of each unit connected in parallel.

Note 2: Serial numbers K-41 and K-42 were supplied with Leach Type 2023.

C13.9 Service Data Sheets

Type K

Model AB

No. 56 to ________

Radio Hdbk.
Added 11-23-42
No. 12

C13.9 Type K, Model AB

The Type K, Model AB, differs from that of Model A only in the type of microphone supply. R-13, modulator cathode resistor, and C-11, microphone by-pass, were deleted. R-15 and R-16 were added in place of R-13 and the low end of the microphone transformer was returned to the junction of the two resistors. Change was made to reduce vibrator hash-pickup in this circuit.

C13.9 Type K, Model AB

Additional Parts List

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-15	Modulator Cathode	200 ohms, 2 watt	IRC	BT-2
R-16	Modulator Cathode	50 ohms, 1 watt	IRC	BW-1

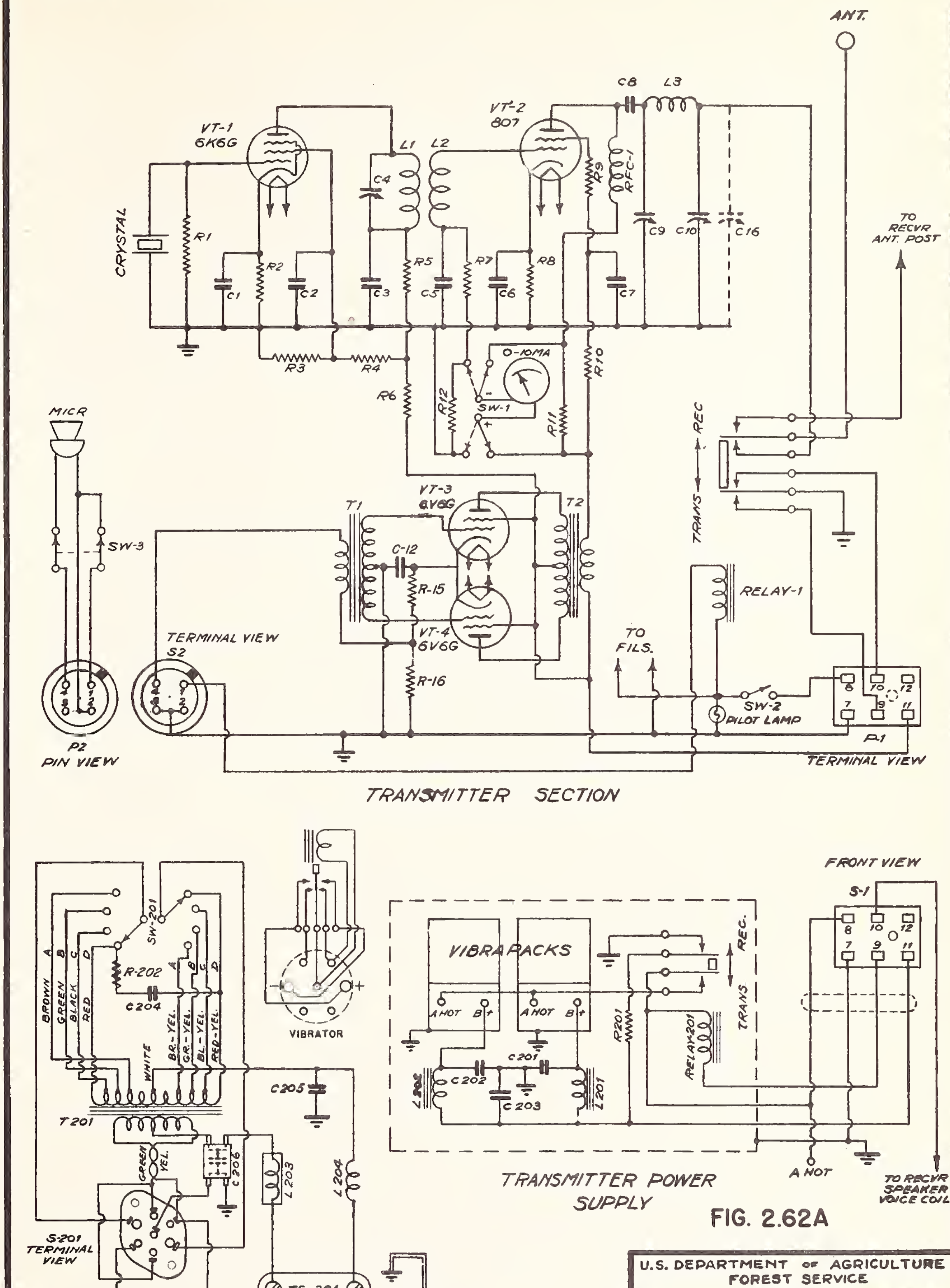


FIG. 2.62A

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE K RADIOPHONE
TRANSMITTER SECTION
MODEL AB
DRAWN BY: P.O.V. CHECKED BY: E.H.S.
DEC. 1, 1938

REVISED 1-30-42
REVISED 10-19-39 E.H.S.

USFS RADIO LAB. DRWG. K-AB-21-B

C13.10 Service Data Sheets

Type KU-R

Model A

Nos. 1 to ____________

Radio Hdbk.
Added 9-25-42
No. 11

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0.0 General Description

The type KU-R Receiver, Model A, is an ultra-high frequency mobile receiver, designed for use in cars and trucks. The companion transmitter is the type KU-T or KU-T2 transmitter. The receiver is tunable over a frequency range of from 30.70 to 40.00 Mc., and is capable of receiving voice signals only from ultra-high frequency radiophones such as USFS Types S, SV, T, KU, U, A, and SX. Both the receiver and its companion transmitter may be operated while the vehicle is in motion. In addition to the tunable range the receiver also has a spot or standby frequency. This spot frequency is crystal controlled to minimize frequency deviation due to vibration of the vehicle and extreme temperature changes and in addition serves as a ready means of accurately locating this common channel without the necessity of tuning the receiver to a transmitted signal.

To permit easy installation in the variously shaped spaces encountered in different cars, the receiver is supplied in three units--tuning unit, amplifier unit, and speaker. The tuning unit is intended for mounting either on the edge of the instrument panel or on the steering post. A universal clamp is provided for this purpose. The amplifier unit is intended for mounting on the firewall of the car, and a plywood board is supplied as a backing for the mounting base. The speaker housing is fastened overhead.

A quarter-wave vertical antenna tuned to the principal operating frequency used is desirable. However, if the receiver is used in conjunction with a transmitter the antenna should be tuned to the frequency of the transmitter where it will function efficiently as a receiving antenna.

The receiver incorporates circuits which minimize the effects of ignition noise and silence the background noise of the receiver during standby periods.

0.1 Electrical Specifications

Frequency Range	30.70 - 40.00
Type of Signal	Voice only
Power Source	Vehicle Storage Battery (6 volts)
Output	Speaker
Tube Complement	1 Type 7L7 RF Amplifier 1 Type 7F7 Variable Oscillator and Mixer 1 Type 7F7 Crystal Oscillator and Tripler 2 Type 7L7 IF Amplifiers 1 Type 6L7 If Amplifier 1 Type 6J7 Noise Amplifier

1 Type 7A6 Noise Rectifier
AVC Rectifier
1 Type 7F7 Noise Threshold Limiter
and squelch
1 Type 7C6 Detector and 1st Audio
Amplifier
1 Type 7B5 Output Amplifier
1 Type 7Y4 Rectifier

0.2 Physical Specifications

Dimensions and Weights

	Length	Height	Depth	Weight
Tuning Unit	4-1/2"	4-3/4"	5-1/8"	3 lbs. 6 oz.
Amplifier Unit	9-1/4"	6-1/4"	4-5/8" *	8 lbs. 13 oz.
Speaker Unit	5-3/4"	3-1/2"	7"	2 lbs. 10 oz.
				14 lbs. 13 oz.

*Tabulated depth of amplifier unit does not include thickness of mounting board, (3/4"), or mounting screw length.

1.0 Detailed Description

The receiver is a superheterodyne employing 3 stages of 1600 kc IF amplification. The width of the IF band-pass is approximately ~~50 kc~~. 40 kc. This comparatively wide band permits reception of modulated oscillators, such as Type S radiophone, and also minimizes the effect of drift of the receiver oscillator and received signal frequency.

Circuits are provided which greatly reduce ignition-type noise. These include a tuned noise amplifier circuit, a diode rectifier for changing the amplified noise pulses to pulsating DC voltage, a noise threshold control tube and a noise blocking injection circuit. A squelch circuit is incorporated which eliminates the background noise during standby periods. A threshold control on this circuit appears on the panel of the tuning unit.

Included in the tuning unit are the r-f amplifier, the first detector, and both the tunable oscillator and the crystal oscillator and a tripler. A matching transformer is provided of such design that the 1600 kc output from the first detector is fed through a transmission line to the input transformer of the first intermediate frequency stage in the amplifier unit. Controls on the panel of the tuning unit are the tuning dial, the volume control with which is combined the on-off switch, the squelch control, and the spot-frequency manual-tune switch.

The effect of different antenna installations upon the tracking of the r.f. stage may be compensated by removing the tuning unit from its case and adjusting a variable capacitor which is in parallel with the r-f grid tuning condenser.

A shorting type twin-tip jack (binding screws on serial #52 and up) is accessible on the side of the amplifier unit to permit measurement of the cathode current of the two 7L7 i-f tubes. This measurement is useful in making the antenna adjustment. A meter in this position will also serve as a carrier strength or tuning meter.

Receptacles are provided on the tuning unit for the antenna transmission line plug, the inter-unit i-f cable, the inter-unit power cable, and the battery power cable.

Receptacles are provided on the amplifier unit for the inter-unit i-f cable, the inter-unit power cable, the tuning meter, and the speaker plug (binding strip for speaker on serial #52 and higher). The speaker circuit is completed to ground either through a relay in the transmitter unit if employed, or by connecting the remaining lead to some suitable point which makes a good metallic connection to the frame or body of the car.

1.2 Signal Circuit

Referring to Fig. 2.62, the Schematic Diagram, it may be seen that the antenna coil L-101 induces signal currents picked up by the antenna, into the r-f grid coil L-102, which is resonated by tuning capacitor C-101, and antenna padder C-150. The signal is amplified by VT-101 and its plate circuit is fed through coupling condenser C-110 to the grid of one of the triode sections of VT-102. The tuned circuit for this section consists of coil L-105 and condenser C-102. The high-frequency variable-oscillator section of the unit employs the other half of VT-102 operating into L-104, the tuned plate coil, and L-103, the tickler feedback coil. C-103, the rear section of the ganged tuning condenser tunes L-104 to a frequency 1600 kc higher than the incoming signal. Injection of the tunable oscillator into the first detector takes place through the inter-element capacity of the tube and the incidental capacity of the circuit wiring, VT-103, the crystal oscillator and tripler, perform essentially the same function as the oscillator section of VT-102 with the exception that the oscillation frequency of the first section is controlled by a crystal. The second section of VT-103 performs the function of tripling the output frequency of the first section and works into a plate circuit consisting of L-106 and C-116. The output of the tripler is coupled to the 1st detector through the small capacity C-148 which consists of about 3 turns of #20 copper wire wrapped around an insulated piece of the same size wire. Operation of either spot frequency or manual tune oscillator is selected by a single pole double throw switch in the "B" supply. The resultant 1600 kc i.f. signal which appears in the plate circuit of the 1st detector is coupled by the matching transformer T-101 through the interunit concentric transmission line and the grid transformer T-102 to the grid of the first i-f amplifier VT-104.

The oscillator and tripler trimmers, C-117 and C-116 respectively, are accessible through a small cover on the back of the tuning unit. On serial No. 52 and higher these trimmers are accessible by removing the unit from its case.

It will be noted that T-102, as well as T-103, T-104, and T-106 have a resistor connected across their respective grid windings. The purpose of these resistors is to lower the effective Q of the winding to produce the necessary 50 kc band width. Values are not specified as these resistors are an integral part of the i-f transformers, and must be replaced at the time a transformer is replaced. The i.f. signal from the grid of VT-104 is fed through the rest of the i-f system which consists of VT-104, VT-105, and VT-106 and their respective transformers T-103, T-104 and T-106. AVC bias is applied to the grids VT-101, VT-104, and VT-105, but not to VT-102 or VT-106. A portion of the signal voltage at the plate of VT-106 is fed to the second diode plate (pin 3) of VT-110 through C-133. The rectified voltage thus produced appears across R-136 and R-137 and is applied as AVC voltage to the grids of the controlled tubes VT-101, VT-104, VT-105, and VT-111. The other portion of the signal is fed through T-106 to the top diode plate of VT-107. The audio signal voltage appears across R-138 and the volume control R-115. C-139 and C-141 provide r.f. filtering. Audio signal voltage is applied to the triode grid of VT-107 through C-140. The plate circuit of VT-107 is resistance coupled to output amplifier VT-108. The primary of the speaker transformer T-107 is in series with the filter network C-145, L-109, and C-146. The purpose of this filter, and also R-155 and C-143 between screen and plate of VT-108, is to attenuate audio frequencies higher than those needed for good intelligibility, thereby decreasing the background noise when receiving weak signals.

1.21 Noise Silencer Circuit

The amplified i-f signal appearing at the grid of VT-106, the third i-f amplifier tube, is also applied to the grid of VT-109, the noise silencer amplifier. The amplified output of VT-109 is rectified by one of the diodes of VT-110. The cathode of this noise rectifier VT-110 is biased so that only the high amplitude noise pulses will be rectified. These rectified pulses are negative in direction and are applied to the injection grid of VT-106 through R-130 and C-131. Thus during the period of a high amplitude noise pulse, such as produced by an ignition system, the plate current of VT-106 is blocked and the noise pulse does not appear in the plate circuit.

Proper positive bias of the cathode of the noise rectified is maintained by the action the noise threshold control tube which is one half of VT-111. This tube functions as a DC amplifier and is controlled by the AVC voltage. Compensation of the noise threshold level to correct for variations of individual sets and tubes is provided by adjustment of the potentiometer R-141 which is located under the lid of the amplifier unit.

1.22 Squelch Circuit

The audio output of the receiver is effectively silenced by the operation of the d-c amplifier, one half of VT-111. The tap point between R-153 and R-154 in the plate circuit of the amplifier is made to go more positive or less positive by the amount of current drawn by the tube. This current, in turn, is controlled by the amount of AVC voltage appearing at the grid of the tube and can further be controlled by a counter positive potential on the grid available from the manual squelch control R-114.

Under "no signal" conditions the grid return of the first audio amplifier, VT-107, is sufficiently negative to prevent operation of the amplifier. Upon application of a signal the AVC voltage produced causes the tap point in the plate circuit of VT-111 (squelch section) to become more positive and thus reduce the negative potential on the audio grid of VT-107 to a point where it starts amplifying the signal. The lower diode plate of VT-107 prevents the positive potential on the grid return from rising to a point that would produce appreciable grid current and consequent distortion.

1.3 Power Supply Circuit

The filaments of all tubes are heated directly from the battery. Plate voltage is supplied from a vibrator power supply employing a tube rectifier. Negative bias for VT-108 is obtained from the drop through R-202, the filter resistor. R-201, the resistor in series with C-202, the buffer condenser, prevents damage to the vibrator or transformer in the event of rupture of C-202.

R-156 is a resistor in series with the pilot lamp to reduce its operating voltage, and thus increase its life.

The total battery drain of the receiver is approximately 5.5 amperes.

2.0 Adjustment and Repair, General

The following tools and equipment are needed for adjusting and repairing the type KU-R, Model A Receiver:

(a) Usual assortment of hand and bench tools.

(b) Electronic d-c voltmeter. Ranges needed- 0-5, 0-10, 0-50, 0-100, 0-250 volts.

(c) Ammeter - 0-10 amperes

(d) Ohmmeter

Note: Items (b) and (d) are usually contained in the same instrument.

(e) Tube Checker

(f) USFS Type A test set

(g) Signal Generator covering the i-f (1600 kc) band and the 30 to 40 Mc band

(h) USFS Type D Frequency Modulated Oscillator

(i) Cathode Ray Oscillograph

(j) Audio Power Output Meter or Rectifier Type AC Voltmeter 0-5

(k) A Variable d-c voltage source capable of being varied from 0-45 volts.

If the receiver fails to operate, the following procedure should be followed to locate the trouble:

1. Make sure that plugs on battery lead, inter-unit power cable, inter-unit i-f cable, speaker cable, and antenna cable are inserted firmly in their sockets, and are making good connection. Work the terminals in and out of their sockets a few times to make sure that contacts are bright. Test each for continuity to pick up possibility of broken wires or faulty internal socket connections.

2. Inspect antenna and antenna transmission line. See that antenna insulators are clean and that all connections are tight.

3. Determine whether full battery voltage is reaching the receiver. This voltage may be measured by pulling the battery lead to the tuning unit part way out of its socket and touching the voltmeter prod to the metal thus exposed. The battery voltage measured at this point with the receiver turned on, and the car motor turned off, should be at least 5.7 volts.

If no voltage is indicated at this point, the trouble may be traced to an open fuse, or a loose or dirty connection of the battery lead at the point where it is connected to the voltage source. If fuse is found to be blown, and a new fuse blows immediately after insertion, trouble is indicated in either the tuning or amplifier units. Remove all tubes from sockets and check for shorts or grounds on the battery buss.

Abnormally low voltage may be caused by poor connections or excessive resistance in the car's wiring. Make sure that the battery cable connections are clean and tight on both ends. Loose connections or excessive resistance in the car's wiring may result in the generator developing excessive voltage which would be harmful to the receiver. A voltage in excess of 8, with the car motor running, would indicate such a condition, and steps should immediately be taken to correct the trouble.

4. If normal battery voltage is reaching the receiver but there is no sound output from the speaker, determine whether the speaker circuit is completed to ground.

The foregoing tests are preliminary to a more detailed servicing. If the trouble is not cleared in steps 1 to 4 refer to sections 2.221 and those that follow.

2.2 RECEIVER DATA

2.21 General

In order to receive modulated-oscillator transmitters such as the type S, the response of the type KU-R Model A Receiver has been made uniform over a pass-band of ~~50~~ 40 kc. This property has been achieved in the i-f amplifier in which the 4 i-f transformers having a center frequency of 1600 kc.

Due to the wide-band response of the i-f system, it cannot be aligned by the usual methods. It is therefore vitally important that the factory adjustments be left unchanged unless the proper equipment is at hand to do this job. Improper procedure will change the wide-band characteristics of the receiver.

2.22 Locating Trouble

1. If the receiver fails to operate, follow the steps outlined under 2.0 "Adjustment and Repair, General". In addition it should be kept in mind that the loktal type tubes employed in this receiver, although electrically efficient, are subject to failure through fracture of the glass seal around the pins. Extreme care should be exercised in pulling and replacing loktal tubes in their sockets to make sure that side strain is not placed on the contact pins. Glass fractures are not readily apparent by visual inspection but can often be seen if carefully investigated. Look over the glass bead around the contact pins of all tubes. A minute fracture will admit air and, although the tube may light normally, it will fail completely in operation. If this fails to clear the trouble, proceed as follows:

2.221 Checking Power Supply

2. The performance of the power supply may be checked by unclamping the hasps on the back of the amplifier unit, thus exposing the wiring. With 6 volts applied to the set, the plate voltage should read approximately 130. If the reading is much less than 130, the negative series resistor (R-202) should be carefully unsoldered, and the open circuit voltage should read approximately 250 volts, indicating that the power supply is in good operating order.

If the open-circuit voltage is substantially lower than this figure, see 2.3 "Power Supply Data".

3. To make further tests the complete receiver should be removed from the car and placed on the test bench. Use a fully charged storage battery for the tests.

4. Inspect the receiver for any physical damage, and for signs of overheating. See that all the tubes are lighted, and that they are making good contact to their socket contacts.

5. Measure the various tube element voltages. The heaters should show full battery voltages, and the voltages on the other elements should

read approximately as shown in table 2. For tube socket diagrams, refer to Fig. 2.62, the Schematic.

Abnormal tube element voltages will suggest the general location of the trouble. Be sure the Manual Tune-Spot Frequency Switch is thrown in the proper direction when making measurements of the two oscillator tubes.

Tube element voltages for the noise amplifier, noise and AVC Rectifier, and Noise Threshold and Squelch tubes are listed in 2.227.

Table 2

Tube-Element Voltages (measured to ground) Volume control and squelch off, and no received signal.

TUBE ELEMENT	VOLTAGE	SOCKET PIN NO.
VT-101 r-f amplifier		
Plate	130	2
Screen	56	3
Cathode	0.8	7
VT-102 Osc. & Mixer		
Osc. Plate	78	6
Osc. Grid	-3.4	5
Mixer Plate	130	3
Mixer Cathode	3.8	2
VT-104 1st i-f amplifier		
Plate	130	2
Screen	48	3
Cathode	0.6	7
VT-105 2nd i-f amplifier		
Plate	130	2
Screen	48	3
Cathode	0.6	7
VT-106 3rd i-f amplifier		
Plate	130	3
Screen	71	4
Cathode	2.0	8
VT-107 1st Audio & 2nd Detector		
Plate	100	2
Cathode	25	7
Diode Plate	25	6
VT-108 Audio Outout		
Plate	125	2
Screen	130	3
Grid	-12.5	6

All measurements to be made with Electronic Voltmeter. Agreement within 5% should be expected with 6 volts applied.

2.222 Checking the h-f Oscillator

6. Detailed procedure for checking the h-f oscillator is included in the service data sheets for the type T, model D. See Sec. C13.7, "Type T, Model D", Item 2.203 "Checking the h-f Oscillator" paragraphs (93) to (98) inclusive. For the type KU-R, model A, paragraph (96) of the foregoing text should be modified as follows:

If the oscillator is operating properly, the actual voltage across R-102 should be between 3.1 and 3.5 volts. If the reading is less than 3.1 volts try a new tube for oscillator-mixer VT-102.

2.223 Checking the Crystal Oscillator and Tripler

7. Make sure that the "Manual Tune-Spot Freq." switch is in the "Spot Freq." position. Connect the electronic voltmeter, 100 volt scale, to the junction of L-108 and R-111 and the ground prod to the chassis. Rotate C-117 with an insulated screw driver and note that the voltage varies as the resonance point of the crystal is passed. If no variation in voltage occurs, it is an indication that the crystal does not oscillate and that it possibly needs cleaning. The crystal should be brought to resonance from the high capacity side of C-117. Resonance is indicated by a sudden dip in the indicated voltage. At resonance the indicated voltage will be approximately 38. (This value is subject to considerable variation).

8. When the crystal oscillator is operating properly, as indicated above, the tripler section may be resonated. With the electronic voltmeter set to the 10 volt scale, clip ground prod to the chassis and the other to pin No. 2, Mixer Cathode, of VT-102. Rotate C-116 with an insulated screw driver. Resonance will be indicated by maximum voltage on the voltmeter.

2.224 Checking the a-f Amplifier

9. With the volume control knob advanced to maximum, and the squelch knob advanced completely to the right hand or "off" position, a "rushing sound" should be heard in the speaker. This sound indicates normal conditions in the audio amplifier circuits and at least some of the preceeding circuits.

10. If no rushing sound is heard, the next step is to introduce a modulated signal into the input of the audio amplifier to see that it is operating. By introducing a signal successively toward the antenna terminal, it may be noted at which point the signal ceases.

11. Detailed procedure for applying an audio signal to the a-f amplifier is outlined for Type T, Model D, receiver in Sec. C 13.7, Type T, Model D, Item 2.204, "Checking the a-f amplifier", paragraphs (99) to (101) inclusive. The audio signal should be applied across the volume control potentiometer R-115. If no output is heard in the speaker, new tubes may be tried for VT-107 and VT-108. Note that volume control is "above ground" and that external audio signal must be applied through coupling condensers.

2.225 Checking the Detector and i-f Amplifier

12. The next portion of the receiver to be checked is the i-f amplifier system. Apply a modulated 1600 kc from a signal generator to the grid of the 3rd i-f amplifier VT-106. The grounded side of the signal generator cord should be connected to the chassis, and the ungrounded side is connected to the grid (top cap) in series with a .0005 mfd capacitor. The usual grid cap connection to T-104 should be left in place. Make sure the "Squelch" knob is in the off or extreme right hand position and the "Volume" knob is set for maximum. Turn up the signal generator attenuator, and adjust the signal generator frequency for the loudest signal in the speaker. When making the frequency adjustment, it may be necessary to reduce the signal generator output to prevent overloading of the receiver. If the observed frequency setting of the signal generator differs slightly from 1600 kc it may indicate some inaccuracy in the signal generator calibration, or that the i-f amplifier was purposely set off frequency slightly for reasons set forth under "Alignment of i-f Amplifier". It does not necessarily indicate mistune of i-f transformer T-106, and for this reason its adjustment must not be altered at this time.

13. If no signal is heard in the speaker at this point, remove the grid clip from the top cap of VT-109. If this causes a signal to be heard, it is possible that VT-109 is defective and should be replaced. If a signal is not heard upon disconnecting the grid cap of VT-109 then check VT-106, T-106 and connections to the diode of VT-107, each in turn. If the signal is still not restored, it may be assumed that the trouble lies in the noise silencer circuits or that the transformer is completely mistuned. See Sec. 2.227, "Checking the Noise Silencer and Squelch Circuits" and Sec. 2.23 "Alignment of i-f Amplifier".

14. It may be possible that the diode of VT-107 is not conducting, and a new tube should be tried for VT-107. Look for faulty connections or components in the circuits associated with the 3rd i-f amplifier VT-106 and detector VT-107.

15. Using the same general procedure as described in paragraph (12), successively apply the modulated signal from the signal generator

to the grids of VT-105 and VT-104. In the case of these tubes, which do not have a top grid cap, the grid will be found on pin No. 6. In the case of each stage thus tested, it should be possible to get a signal of the same intensity at the speaker with the attenuator of the signal generator reduced in each successive case. In no event should it be necessary to advance the attenuator to obtain the same output as the previous stage. If such should be the case, obviously the stage under test is at fault. Likewise, if the signal disappears at the stage under test, then that stage may be assumed to be at fault. Try a new tube in the stage at fault, and examine the connections and components of the stage under test.

2.226 Checking the Converter and Input Circuits

16. Directions for checking the h-f oscillator and the crystal oscillator and tripler circuits were outlined above in sections 2.222 and 2.223 respectively. Assuming that this check has been made, the next step is the introduction of the 1600 kc modulated signal used above to grid pin No. 4 of VT-102, through a 2,000 ohm series resistor. Leave grid pin #4 normally connected to the circuit for this test. It will be noted that the signal generator attenuator will have to be turned well up at this point. Should no signal be heard at this point, try a new tube for VT-102 and inspect the wiring and components associated with this circuit. The inter-unit i-f cable should be checked at this point with an ohmmeter to determine whether it has become damaged or shorted.

17. The next step is the introduction of a modulated signal on the operating frequency of the receiver at the antenna terminal. Although many signal generators do not contain a 30 to 40 Mc band, their output is generally sufficient on the second harmonic of a lower frequency to give a useable signal. The signal may also be obtained from a Type A test set. Put the test set in operation as a modulated oscillator (see Sec. C12.301, Type A Test Set, Item 1.2). Tune the test set to approximately 36 Mc, and rotate the tuning condenser of the receiver until the signal is heard. If no output is heard, and if previous tests have shown no trouble, the fault will be in the input circuit to the receiver or the mixer. Circuits associated with the signal grid of VT-101 (pin No. 6) and mixer grid of VT-102 (pin No. 4) should be examined for faulty components or connections. Try new tubes for VT-101 and VT-102.

2.227 Checking the Noise Silencer, AVC, and Squelch Circuits

18. With the squelch control knob turned "off" or to the extreme right hand position, a normal rushing sound should be heard in the speaker. With no input signal received, turning the Squelch knob to the left should quiet or squelch this noise. Check to determine if this condition exists.

19. Apply a modulated signal from the signal generator to the antenna coil of the receiver, and adjust the attenuator for minimum signal which may be heard with the squelch knob in the off position. With this small signal input, adjust the squelch knob to the left to a point where the signal just disappears, then any signal in excess of this amount should cause the set to again resume normal operation.

20. If this effect is not noted, check the squelch control and the components associated with this circuit. Try a new tube for VT-111, and see that the voltages on the squelch section of VT-111 are approximately the same as indicated on Fig. 2.62. If the squelch control range is limited to one end of the manual control, (full to the right) it may be necessary to alter the value of divider resistor R-152, in the plate circuit of VT-111. To open up the range of control reduce this value from 470,000 ohms to 400,000 ohms.

21. To check the noise silencer apply some source of noise voltage such as the output from a door bell buzzer between the antenna terminal and ground. Connect the electronic voltmeter between the junction of R-130 and C-131, and ground. Set the meter to the 10 volt scale, and note that a voltage reading will be obtained which may be brought to a peak by adjustment of the trimmer on T-105. The exact value of this reading will be determined by amount of noise applied to the receiver. If the peak indication above is obtained, it may be assumed that the noise amplifier VT-109 and the noise diode VT-110 are operating properly.

22. If the voltage does not peak upon tuning of T-105 then examine the connections and components of these circuits. Try new tubes in the place of VT-109 and VT-110.

23. The Noise Threshold Control is located in the upper side of the amplifier unit and is adjusted by means of a screw driver slot in its shaft. A cathode-ray oscilloscope should be used at this point. The high input terminal of the scope should be connected in series with a 1/2 megohm resistor, to the junction of T-106 and R-138. The low terminal should be grounded to the chassis. With a modulated signal applied to the antenna terminal of the receiver, ~~a picture~~ the Limiter Threshold Control is then set so that the observed wave shape of the modulated signal at any input and any degree of modulation, shows no indentation. This indentation may be noted if the input signal is large, and the control be rotated to its maximum position.

24. If the above characteristics do not occur, check the connections and components. Check to see that the voltages are approximately as listed in Fig. 2.62. Try a new tube for VT-111.

TABLE 3

Tube-element voltages (measured to ground). Volume Control and Squelch off, and no received signal.

Tube Element	Voltage	Socket Pin No.
VT-109 Noise Amplifier		
Plate	130	3
Screen	72	4
Cathode	1.8	8
VT-110 Noise & AVC Rect.		
Noise Rect. Plate	0	6
Noise Rect. Cathode	50	6
AVC Plate	-0.8	3
AVC Cathode	12	2
VT-111 Noise Threshold & Squelch DC Amp.		
Noise Threshold Plate	39	6
Noise Threshold Grid	-0.6	5
Squelch Plate	38	3
Squelch Grid	-0.7	4

All measurements to be made with Electronic Voltmeter. Agreement within 5% should be expected with 6 volts applied.

2.23 Alignment of i-f Amplifier

25. On rare occasions it may be necessary to tune one or more of the i-f transformers due to replacement of a defective unit or because of mechanical damage. As pointed out previously, this adjustment requires a specially designed frequency-modulated oscillator and an oscilloscope. The frequency-modulated oscillators which are commercially available for aligning broadcast receivers are not suitable for this purpose.

26. The i-f amplifier in the Type KU-R, Model A, is similar in many respects to that in the type T, Model D. Although the i-f frequencies are different, the transformers in both amplifiers provide the same width of pass-band, and the aligning techniques are similar. The aligning instructions for the Type T, Model D, may be used as a guide for aligning the Type KU-R, Model A receiver. See Sec. C13.7, "Type T, Model D", paragraphs (109) to (154) inclusive.

27. The following differences between the two receivers should be kept in mind:

a. In some of the KU-R receivers, the i-f transformers deviate slightly from the nominal frequency of 1600 kc. The reason for this deviation is that the tripled frequency of the crystal may in some cases deviate as much as 15 kc. The i-f transformers as tuned at the factory will maintain their adjustment over long periods of time, and resetting should not be attempted by any person other than a competent radio technician. The method of arriving at the precise i-f frequency is given in the following example:

> The desired spot frequency is 38,820 kc. The crystal supplied is 13,469 kc, giving a tripled frequency at the mixer grid of 40,407 kc. The difference between these two frequencies is seen to be 1587 kc. This is the i-f frequency to be used to bring the spot frequency at the center of the i-f.

b. Should it ever become necessary to replace crystals in the field, it is important that a crystal of the same frequency be obtained. If the spot frequency is changed it will be necessary to obtain a new crystal with the same deviation as the one being replaced or preferably the i-f system should be retuned to a center frequency of 1600 kc and the new crystal obtained to within 1 kc deviation at its fundamental frequency. The frequency reading marked on the crystal holder may be taken as substantially correct. If the deviation at the tripled frequency is found to be $\pm$ 3 kc or less, the i-f may be aligned to 1600 kc.

c. If the i-f frequency is other than 1600 kc, it will not be possible to use the "marker" crystals. It is then necessary to substitute an unmodulated frequency from the signal generator. This frequency should be the i-f frequency chosen, and will serve only as the center marker. The width of the pass-band may then be measured by varying the signal generator frequency. This will cause the marker signal to move from one side of the crest to the other. The width of these limits may then be taken to be the width of the i-f pass-band.

d. The i-f frequency of the KU-R, Model A, is 1600 kc, while that of the Type T, Model D, is 4050 kc. The Type D frequency-modulated oscillator used for alignment is provided with a 1600 kc oscillator coil, and with 1575 kc and 1625 kc "marker" crystals.

e. I-f transformer couplings are not adjustable in the Type KU-R. The procedure of Paragraphs (155) to (163) inclusive Type T, Model D, Sec. C13.7 are accordingly not applicable.

2.24 Alignment of r-f Circuits

28. On rare occasions it may be necessary to realign one or more h-f tuned circuits, due to replacement of a damaged coil or tuning capacitor. This realignment should be undertaken only if necessary, and then only be a competent technician.

2.241 H-F Oscillator

29. Make sure the dial hub is tight on the capacitor shaft, and that it indicates zero with the plates fully meshed. Turn the capacitor plates so that they are fully open. Measure the frequency of the h-f oscillator coil L-104 with the Type A test set, using the technique in C12.301, "Type A Test Set", Item 2.03. Greater accuracy may be obtained if a more precise type of frequency meter is available. Since the i-f frequency is tuned to (or near)* 1600 kc, the measured frequency should be 1.6 Mc (or 1600 kc) higher than the tuning range of the receiver. This frequency should read 41.6 Mc. If it differs from this value, it should be corrected by adjustment of the oscillator plate coil L-104. This adjustment is made by carefully shifting the position of the half-turn at the top of the coil form. As this half-turn is rotated in one direction it increases the inductance of the coil and lowers it in the other direction.

30. Turn the tuning knob until the condenser plates of C-103 are fully meshed. Again measure the frequency. If it is some value other than 32.33 Mc, the outer rotor plates must be carefully bent toward or away from the stator plates to obtain exactly the above reading.

* See Sec. 2.23, Type KU-R, Model A, Item 27 (a) for deviation.

31. In rare instances it may be found that the adjustment under (29) will not permit a frequency as high as 41.6 Mc to be obtained. If such is the case, the frequency must be made as high as possible. In any event, the range stated in (30) must be reached.

2.242 R-f and Converter Grid Circuit

32. It is assumed that the oscillator adjustments have been made as outlined in the foregoing paragraphs. With the tuning condenser plates about 3/4 meshed, introduce a modulated signal into the antenna terminal from a signal generator. Place the terminals of the power output meter or AC voltmeter in parallel with the speaker leads. Carefully tune the output of the signal generator to resonance with the receiver, and reduce the signal level to the smallest amount which may be heard in the speaker. Note the reading of the output meter. With a polyiron and brass wand, determine whether the mixer grid coil L-105 is resonated by noting increase or decrease in output meter reading as iron and then brass tips are inserted in coil. If an increase or decrease in the signal output is noted, the rotor plates of C-102 may be bent slightly to compensate for the discrepancy.

33. Try the "wand" on L-102. Any discrepancy may be compensated by varying the adjustment of C-150.

34. Set the signal generator to about 38 Mc, and note whether L-105 and L-102 are still in resonance as indicated by the reading on the output meter. If they are very far out, realignment should be made by altering the oscillator coil adjusting loop. If this is done the operations in paragraph 32 must be repeated.

35. Repeat the procedure of (32) and (33).

36. Recheck on the entire procedure as outlined above until the tracking is reasonably close over the entire frequency range.

37. It is sometimes helpful to examine the proximity of the leads of L-105 to the chassis and other components. Decreasing or increasing this spacing may change the capacity sufficiently to bring the tracking to the desired spot.

38. In manufacture, the tolerance of the coils is held to very close limits, and should the coils become damaged they should be replaced only with tested units.

39. If a calibrated signal generator is at hand, it would be well to check the overall sensitivity at this point. With an applied signal of about 1.5 microvolt, 30% modulated, set the volume control so that the output meter reads 40 millwatts. Cut the modulation, and again

note the output meter indication. If the reading is less than 10 milliwatts, the signal input should be cut down. Repeat this procedure until the above two outputs are 40 and 10 milliwatts respectively. The attenuator then reads the sensitivity of the receiver in microvolts.

40. The sensitivity in microvolts should be 1.8 or less. If the reading is greater than 1.8, it may be assumed that the receiver is not tracking closely enough, or that the i-f has not been properly aligned.

2.243 Locating the Spot Frecuency

41. Throw the "Manual Tune - Spot Freq." switch to "Spot Freq." Carefully tune the signal generator until the modulated signal reading is maximum on the output meter. Throw the switch to "Manual Tune", and carefully tune the receiver dial until the output is greatest on the output meter. Leave the receiver set at this position, and alternately throw the switch from one position to the other. The signal as indicated on the output meter should remain the same. If it is not the same, repeat the above procedure until the readings are equal. Mark this spot on the dial for ready reference.

2.25 Adjustments After Installation

42. Replace the amplifier and speaker units in the vehicle. Leave the cover off the tuning unit, but plug in the interconnecting cables and the antenna cable. Tune in a very weak signal on the frequency at which the receiver will be used most. This signal may either be from a distant transmitter or from a Type A Test Set, so placed that it produces a modulated signal of minimum receivable intensity. Adjust padder C-150* for maximum signal in the speaker. If a 0-10 ma. milliammeter is available it may be plugged into the meter jack J-101 (terminal strip on sets #52 and up) located on the side of the amplifier unit. The minimum meter reading indicates maximum signal and correct tuning.

43. Replace the tuning unit cover and remount the unit.

44. Adjust the squelch control using the procedure outlined in paragraphs (18) and (19).

2.3 Power Supoly Data

If the tests performed under 2.221, indicate the power supply is defective, the following procedure should be used to locate the trouble:

1. The vibrator normally produces a low hum when operating, if this hum is not heard with the receiver turned on the vibrator is not operating. An abnormally loud hum may indicate mechanical vibration of the amplifier unit, or overload. Do not permit a sustained overload.

* On some KU-R, Model A this capacitor is located above the chassis, and on others it is below.

2. Snap the receiver switch on and off several times to determine whether the vibrator starts readily.

3. With the vibrator operating, remove the rectifier tube VT-201 from its socket. Normally this should not change the pitch of the vibrator perceptibly. If the pitch is raised noticeably, with the tube removed, accompanied by a reduction in intensity, an overload is indicated. Check the filter capacitors C-203 and C-204 for possible shorts.

4. Measure the primary voltage at the input to the power supply. This voltage should be the same as that previously measured at the battery-lead plug.

5. If the vibrator does not hum, it may have failed to start, it may be sticking, or voltage may not be reaching its terminals. These symptoms may be checked as follows:

(a) If the vibrator has failed to start, full battery voltage should be read at socket terminals 2 and 3.

(b) If the vibrator is sticking, the socket terminals will show a subnormally low voltage. Possibly 4 volts on one pin and 0.2 volts on the other.

(c) If no voltage is indicated at either pin, there is a fault between the input-terminal #2 and the primary center-tap of T-201. Test RFC-201 and C-201, also check primary of T-201 for continuity. If full battery voltage is reaching one of the socket pins of the vibrator, but no voltage is reaching the other, an open is indicated in the primary of T-201.

6. Replace the vibrator if the above tests show it is defective. If the vibrator is found to stick, the buffer condenser C-202 should be tested to see that it is not open, shorted, or of the wrong capacity.

7. Try a new tube for VT-201. If this does not restore normal voltage, repeat the procedure of paragraph (3) above. A defective tube which has lost its emission will not reveal filter faults in the above tests.

8. If the output voltage is still zero, check filter resistor R-202 for a possible open.

9. With the rectifier tube VT-201 removed from its socket, measure the a-c voltage across each half of power transformer T-201 secondary. Each half should read approximately 240 volts, and the two readings should not differ by more than 5 volts. If the two voltages are less than this amount, or the two voltages differ by more than the above amount, shorted turns in the secondary are indicated.

10. Check all components such as the filter and buffer condensers with their leads alternately connected. Note the output voltage readings at each position. Some faults in these components become evident only when high voltage is applied, and do not show up under the low voltage of the ohmmeter.

11. If the location of the trouble is still in doubt, compare the circuit with that of the schematic, Fi. 2.62. Inspect the wiring for poor connections, ground, and opens.

12. At the conclusion of the repairs, see that the power supply voltage checks approximately 130 volts. Snap the power switch on and off to see that the vibrator starts reliably.

2.5 Parts List

2.51 Capacitors

Symbol	Component	Rating	Manufacturer	Type
C-101	RF Grid Tuning		Hammarlund	
C-102	Converter Grid Tuning		Part of C-101	
C-103	HF Oscillator Tuning		Part of C-101	
C-104	RF Grid	.00025 mfd mica	Solar	
C-105	RF Grid Return By-pass	.001 mfd mica	Solar	
C-106	Var.Osc.Grid Return By-pass	.00005 mfd mica	Solar	MO-1410
C-107	Var.Osc.Plate Return By-pass	.0005 mfd mica	Solar	
C-108	RF Cathode By-pass	.001 mfd mica	Solar	MT-1327
C-109	RF Screen-Grid By-pass	.001 mfd mica	Solar	MT-1327
C-110	Mixer Grid	.0001 mfd mica	Solar	MO-1416
C-111	Mixer Cathode By-pass	.01 mfd 400 V. paper	Solar	S-0219
C-112	Mixer Plate Return By-pass	.01 mfd 400 V. paper	Solar	S-0219
C-113	Tripler Plate Return By-pass	.0005 mfd mica	Solar	
C-114	Crystal Osc. Plate Return By-pass	.0005 mfd mica	Solar	
C-115	RF Coupling Condenser - Crystal Plate to Tripler Grid	.0001 mfd mica	Solar	MO-1416
C-116	Tripler Tuning		Mallory	
C-117	Crystal Osc. Tuning		Mallory	
C-118	1st IF Grid Return By-pass	.01 mfd 400 V. paper	Solar	S-0219
C-119	1st IF Cathode By-pass	.01 mfd 400 V. paper	Solar	S-0219

2.51 Capacitors (Cont'd.)

Symbol	Component	Rating	Manufacturer	Type
C-120	1st IF Screen Grid By-pass	.01 mfd 400 V paper	Solar	S-0219
C-121	1st IF Plate Return By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-122	2nd IF Grid Return By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-123	2nd IF Cathode By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-124	2nd IF Screen Grid By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-125	2nd IF Plate Return By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-126	Noise Amp.Cathode By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-127	Noise Amp. Screen By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-128	Noise Amp.Plate Return By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-129	3rd IF Cathode By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-130	3rd IF Injector Grid RF By-pass	.000025 mfd mica	Solar	MO-1406
C-131	3rd IF Injector Grid Coupling	.01 mfd 400 V.paper	Solar	S-0219
C-132	Noise Amp. Plate Coupling	.000025 mfd mica	Solar	MO-1406
C-133	AVC Rect. Coupling (Plate)	.0001 mfd mica	Solar	MO-1416
C-134	3rd IF screen By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-135	3rd IF Plate Return By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-136	Noise Rect. Cathode By-pass	.1 mfd paper	Solar	MPW-4147
C-137	AVC Rect. Cathode By-pass	.01 mfd 400 V.paper	Solar	S-0219
C-138	AF Amplifier Coupling	.01 mfd 400 V.paper	Solar	S-0219
C-139	Audio Diode RF Filter	.0001 mfd mica	Solar	MO-1416
C-140	1st Audio Grid Coupling	.01 mfd paper	Solar	S-0219
C-141	Audio Diode RF Filter	.0001 mfd mica	Solar	MO-1416

2.51 Capacitors (Cont'd.)

Symbol	Component	Rating	Manufacturer	Type
C-142	Audio Cathode By-pass Part of C-204	20 mfd 250 V. Electrolytic	Mallory	FPD-217
C-143	Audio High Freq. Attenuator	.003 mfd mica	Solar	MW-1235
C-144	AVC Time Constant	.1 mfd paper	Solar	MPW-4147
C-145	Audio High Freq. Attentuator	.004 mfd mica	Solar	MW-1237
C-146	Audio High Freq. Attenuator	.004 mfd mica	Solar	MW-1237
C-147	Audio Output Grid Bias By-pass	.1 mfd paper	Solar	MPW-4147
C-148	Tripler RF Coupling	.0000005	3 Turns #20 tinned copper wire wound over insulation of second pi	
C-201	RF filter	.5 mfd 50 V DC	Mallory	481
C-202	Buffer	.005 mfd 1600 V DC paper	Mallory	OT371
C-203	Filter	16 mfd 250 V DC Elect.	Mallory	BB34
C-204	Filter	20 mfd 250 V.Elect.	Mallory	FPD-217*

2.52 Inductors

Symbol	Component	Description
L-101	Antenna	Single turn #20 insulated hook-up wire fitted over ground end of L-102
L-102	RF Grid	
L-103	Var. Osc. Grid	
L-104	Var. Osc. Plate	
L-105	Mixer Grid	
L-106	Tripler Plate	
L-107	Crystal Osc. Grid	

* Part of C-142

2.52 Inductors (Cont'd)

Symbol	Component		Description
L-108	Crystal Osc. Plate		
L-109	High Freq. Attenuator		
RFC-101	RF Plate Choke		
RFC-201	RF Filter	Mallory	RF-582

2.53 Resistors

Symbol	Component	Rating	Manufacturer	Type
R-101	RF Grid Isolating	5,000 ohms 1/2 watt	IRC	F 1/2
R-102	Var. Osc. Grid Leak	10,000 ohms 1/2 watt	IRC	BT 1/2
R-103	Var. Osc. Plate Drop	47,000 ohms 1/4 watt	IRC	BT-1/4
R-104	RF Cathode	300 ohms 1/2 watt	IRC	BT-1/2
R-105	RF Screen Dividing	150,000 ohms 1/4 watt	IRC	BT-1/4
R-106	RF Screen Dropping	75,000 ohms 1/2 watt	IRC	BT-1/2
R-107	Mixer Cathode	5,000 ohms 1/2 watt	IRC	BT-1/2
R-108	Mixer Plate Return Isolating	1,000 ohms 1/4 watt	IRC	BT-1/4
R-109	Tripler Plate Return Isolating	47,000 ohms 1/4 watt	IRC	BT-1/4
R-110	Tripler Grid Leak	100,000 ohms 1/4 watt	IRC	BT-1/2
R-111	Crystal Osc.Plate Isolating	47,000 ohms 1/4 watt	IRC	BT-1/4
R-112	Crystal Osc. Grid Leak	5,000 ohms 1/2 watt	IRC	BT-1/2
R-113	Squelch Voltage Divider	75,000 ohms 1/2 watt	IRC	BT-1/2

From Serial No. 91 on the rating of 75,000 ohms has been decreased to 50,000 ohms.

Symbol	Component	Rating	Manufacturer	Type
R-114	Squelch Control	100,000 ohms	Central lab.	NF-111
R-115	Volume control	50,000 ohms	Central lab.	P-115
R-116	1st IF Grid Return Isolating	100,000 ohms 1/2 watt	IRC	BT-1/2
R-117	AF Amplifier Grid Filter	270,000 ohms 1/4 watt	IRC	BT-1/4
R-118	1st IF Screen Dropping	150,000 ohms 1/4 watt	IRC	BT-1/4

2.53 Resistors (Cont'd)

Symbol	Component	Rating	Manufacturer	Type
R-119	1st IF Cathode	300 ohms 1/2 watt	IRC	BT-1/2
R-120	1st IF Plate Isolating	1,000 ohms 1/4 watt	IRC	BT-1/4
R-121	2nd IF Grid Isolating	100,000 ohms 1/2 watt	IRC	BT-1/2
R-122	2nd IF Cathode	300 ohms 1/2 watt	IRC	BT-1/2
R-123	2nd IF Screen Dropping	150,000 ohms 1/2 watt	IRC	BT-1/2
R-124	2nd IF Plate Isolating	1,000 ohms 1/4 watt	IRC	BT-1/2
R-125	Noise Amp. Cathode	1,000 ohms 1/4 watt	IRC	BT-1/4
R-126	Noise Amp. Screen Dropping	150,000 ohms 1/4 watt	IRC	BT-1/4
R-127	Noise Amp. Plate Isolating	1,000 ohms 1/4 watt	IRC	BT-1/4
R-128	3rd IF Cathode	300 ohms 1/2 watt	IRC	BT-1/2
R-129	3rd IF Injector Grid Return	1 megohm 1/4 watt	IRC	BT-1/4
R-130	Noise Rect.Plate Isolating	270,000 ohms 1/4 watt	IRC	BT-1/4
R-131	Noise Rect. Plate Return	150,000 ohms 1/4 watt	IRC	BT-1/4
R-132	3rd IF Screen Dropping	15,000 ohms 1/2 watt	IRC	BT-1/2
R-133	AVC Rect. Bus Isolating	470,000 ohms 1/4 watt	IRC	BT-1/4
R-134	3rd IF Plate Isolating	1,000 ohms 1/4 watt	IRC	BT-1/4
R-135	AVC Rect. Cathode	47,000 ohms 1/4 watt	IRC	BT-1/4
R-136	AVC Rect. Diode Load Divider	470,000 ohms 1/4 watt	IRC	BT-1/4
R-137	AVC Rect. Diode Load Divider	270,000 ohms 1/4 watt	IRC	BT-1/4
R-138	Audio Diode Filter	100,000 ohms 1/2 watt	IRC	BT-1/2
R-139	AVC Cathode Voltage Divider	470,000 ohms 1/4 watt	IRC	BT-1/4
R-140	Noise Threshold Grid Voltage Divider	1 megohm 1/4 watt	IRC	BT-1/4

2.53 Resistors (Cont'd)

Symbol	Component	Rating	Manufacturer	Type
R-141	Noise Threshold Control	500,000 ohms variable	Central lab.	N-103
R-142	Noise Threshold Grid Isolating	10 megohms 1/2 watt	IRC	BT-1/2
R-143	1st Audio Grid Isolating	10 megohms 1/2 watt	IRC	BT-1/2
R-144	Squelch Grid Isolating	10 megohms 1/2 watt	IRC	BT-1/2
R-145	Noise Threshold Grid Limiting	1 megohm 1/4 watt	IRC	BT-1/4
R-146	Audio Cathode	47,000 ohms 1/4 watt	IRC	BT-1/4
R-147	1st Audio Cathode Voltage Divider	200,000 ohms 1/4 watt	IRC	BT-1/4

From Serial No. 91 on the rating of 200,000 ohms has been decreased to 100,000 ohms.

Symbol	Component	Rating	Manufacturer	Type
R-148	Noise-Threshold-Plate Voltage Divider	470,000 ohms 1/4 watt	IRC	BT-1/4
R-149	1st Audio Plate Isolating	470,000 ohms 1/4 watt	IRC	BT-1/4
R-150	Squelch Grid	2 megohms 1/2 watt	IRC	BT-1/2
R-151	2nd Audio Grid Isolating	470,000 ohms 1/4 watt	IRC	BT-1/4
R-152	Squelch Plate Isolating	470,000 ohms 1/4 watt	IRC	BT-1/4
R-153	Squelch Plate Divider	1 megohm 1/4 watt	IRC	BT-1/4

From Serial No. 91 on the rating of 1 megohm has been increased to 3 megohms.

Symbol	Component	Rating	Manufacturer	Type
R-154	Squelch Plate Divider	470,000 ohms 1/4 watt	IRC	BT-1/4
R-155	HF Audio Attenuator	15,000 ohms 1/2 watt	IRC	BT-1/2
R-156	Pilot Lamp Voltage Dropping	5 ohms 1/2 watt	IRC	BW-1/2
R-157	Noise-Threshold-Plate Voltage Divider	270,000 ohms 1/4 watt	IRC	BT-1/4
R-201	Buffer Capacitor Series	5,000 ohms 1/2 watt	IRC	BT-1/2
R-202	Power Supply Filter	400 ohms 2 watt	IRC	BW-2
R-203	Vibrator	100 ohms 1/2 watt	IRC	BW-1/2

2.54 Tubes

Symbol	Component	Manufacturer	Type
VT-101	RF Amplifier	Sylvania	7L7
VT-102	Variable HF Oscillator & Mixer	Sylvania	7F7
VT-103	Crystal Oscillator and Tripler	Sylvania	7F7
VT-104	1st IF Amplifier	Sylvania	7L7
VT-104	2nd IF Amplifier	Sylvania	7L7
VT-105	2nd IF Amplifier	Sylvania	7L7
VT-106	3rd IF Amplifier	Sylvania	6L7
VT-107	2nd Detector & 1st Audio Amplifier	Sylvania	7C6
VT-108	Output Amplifier	Sylvania	7B5
VT-109	Noise Amplifier	Sylvania	6J7
VT-110	Noise Rectifier & AVC Rectifier	Sylvania	7A6
VT-111	Noise Threshold Limiter & Squelch	Sylvania	7F7
VT-201	Rectifier	Sylvania	7Y4

2.55 Transformers

Symbol	Component	Manufacturer	Type
T-101	1st IF Output	Meisner	23247
T-102	1st IF Input	Meisner	
T-103	2nd IF Transformer	Meisner	22919
T-104	3rd IF Transformer	Meisner	22919
T-105	Noise Amplifier Transformer	Meisner	23246
T-106	4th IF Transformer	Meisner	22919
T-107	Receiver Output	Thordarson	T-14S81
T-201	Receiver Power	Thordarson	T-14R39

2.56 Switches

Symbol	Component	Manufacturer	Type
SW-101	Battery Power	Central lab	Part of R-115
SW-102	Spot Freq. - Manual Tune	H & H	SPDT Toggle-Short Shank - Nickle Plated

2.59 Miscellaneous

Symbol	Component	Manufacturer	Type
	Vibrator, Power Supply	Mallory	294
	Socket, Vibrator	Amphenol	MIP 4
S-1	Power Supply Cable (Tuning Unit)	Amphenol	MIP 8
S-2	Power Supply Cable (Amplifier Unit)	Amphenol	MIP 8
S-3	Antenna Lead-in		
S-4	Socket, Inter-unit IF		
S-5	Socket, Inter-unit IF		
J-101	Jack, Power Supply Cable	Amphenol	78-1L
	Plug, Power Supply Cable	Amphenol	71-1L
	Fuse Holder, Power Supply Cable Fuse, Battery Cable	Buss 10 Amp.	Buss
J-102	Jack, Speaker Lead	Amphenol	78-1L
	Plug, Speaker Lead	Amphenol	71-1L
J-103	Jack, Signal Strength Meter	Mallory	432
	Lamp, Pilot	GE	51
	Sockets, Tube 7 required	Amphenol	88-8X
	Sockets, Tube 2 required	Amphenol	MIP 8
	Sockets, Tube 3 required	Amphenol	88-8XT
	Socket, Crystal 1 required	Amphenol	54-2

2.59 Miscellaneous (Cont'd)

Symbol	Component	Manufacturer	Type
	Socket, Pilot Lamp		
	Dial, Tuning	National	BM
	Cable, Inter-unit IF	Bassett	BCF-64-200
	Cable, Inter-unit Power	Belden	
	Plug, Inter-unit Power Cable (2 required)	Amphenol	PM8-11
	Crystal and Holder Assy.	Oregon Electronic Mfg. Co.	JXA 3
	Knobs, Squelch & Vol. Control		
	Speaker		
	Speaker Housing		

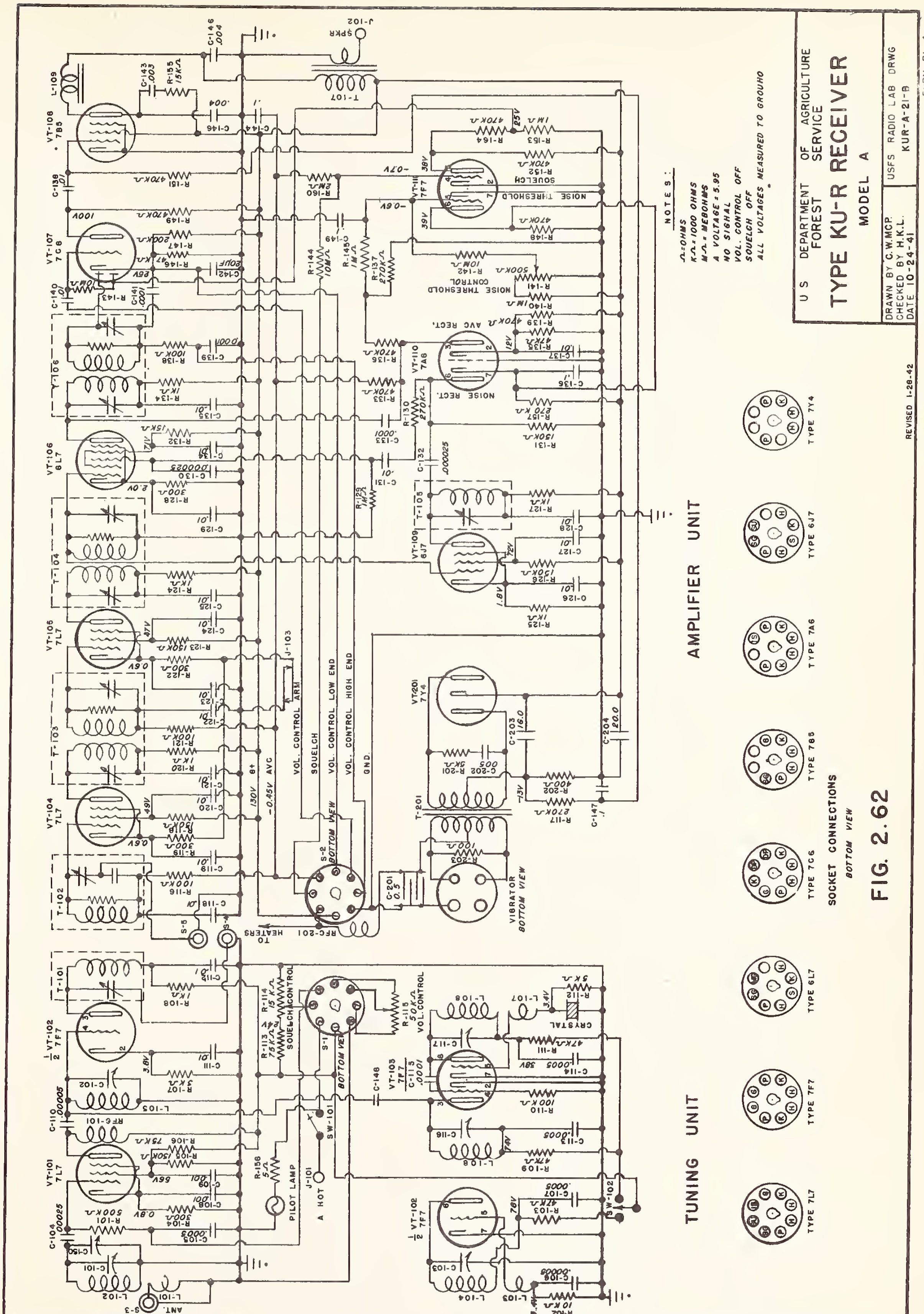

FIG. 2.62

RADIO HDBK.
ADDED 2-16-42
NO. 11

C13.11 Service Data Sheets

Type KU-T

Note: This section covers the Type KU-T transmitter only. The companion receiver, the Type KU-R, appears in Sec. C13.10.

Model	A	Nos.	1	to	12	Inc.
Model	AA	Nos.	13	to		Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.

Note: For installation instructions see "Instructions for Installing", furnished with radiophone.

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0.0 General Description

The Type KU-T Transmitter, Model A, is a mobile ultra-high-frequency unit intended for use on Forest Service cars and trucks. The companion receiver is the Type KU-R. The crystal-controlled transmitter operates on one of the frequencies assigned to the Forest Service (or cooperating agency) between 30 and 39 Mc, and transmits voice signals only. Power is taken from the vehicle storage battery, and the rated transmitter power output is 9 watts. The microphone has a "push-to-talk" button, similar to the Type M. The antenna is a vertical fishpole, which may be mounted on a bumper support, and which serves both transmitter and receiver.

To facilitate installation in the space available on a car, the set is supplied in units, with inter-connecting cables. These units are:

(1) Transmitter, usually mounted on rear of fire wall, on right-hand side of cab.
(2) Transmitter power supply, usually mounted on front of fire wall (under hood) on right side of car.
(3) Collapsible fishpole antenna.

0.1 Electrical Specifications

Frequency Range, Transmitter	One specific frequency assigned to Forest Service between 30 and 39 Mc.
Frequency Control	Crystal
Type of Signal	Voice
Distance Range	Optical Path
Power Source	Vehicle Storage Battery
Power Output	9 Watts
Input	Hand Microphone
Antenna	Vertical Fishpole
Tube Complement	1 Type 89 Oscillator 1 Type 89 Doubler 1 Type 807 Final Amplifier 2 Type 6V6 Modulators

0.2 Physical Specifications

Table 1 lists weights and overall dimensions of the units of the Transmitter.

Table 1

Unit	Height	Width	Depth	Weight
Transmitter	7-3/4" °	12-1/4"	7-3/4"	13 lbs. 5 oz.
Power Supply	6-1/4" °°	9-3/4"	6-1/2"	20 lbs. 13 oz.

°Tabulated transmitter height does not include mounting brackets which project 3/4" top and bottom.

°°Tabulated power-supply height does not include mounting flange, which projects 1-1/2" top and bottom.

1.0 Detailed Description

As noted above, the Radiophone is supplied in units which are interconnected with cables. The transmitter unit contains the radio-frequency and modulator sections of the transmitter. The power-supply unit contains the high-voltage power supply for the transmitter only. The companion Type KU-R receiver has its separate power supply.

1.1 Transmitter Circuit

A Type 89 crystal oscillator supplies power at three times the fundamental frequency of the crystal. A Type 89 doubler excites a Type 807 modulated final amplifier. The modulator consists of a pair of Type 6V6 tubes, operating class AB. Grids of the modulator tubes are driven directly from the secondary of microphone transformer T-1, thus eliminating the need for an intermediate speech amplifier.

Referring to Fig. 2.62, the Schematic Diagram, it is seen that a "Tri-Tet" crystal oscillator is used. The cathode, grid, and screen operate as a triode crystal oscillator on the fundamental frequency of the crystal. The screen is bypassed to ground, so that energy is electron-coupled to the output circuit. The plate tank circuit, consisting of capacitor C-2 and inductor L-2, is tuned to the third harmonic of the crystal frequency.

Third-harmonic voltage developed across the oscillator plate tank is coupled to the grid of doubler VT-2 through coupling capacitor C-4. The doubler plate tank circuit, consisting of capacitor C-6 and inductor L-3, is tuned to the sixth harmonic of the crystal frequency.

The sixth-harmonic voltage induced in final-amplifier grid coil L-4 by L-3 is applied to the grid of final amplifier VT-3. C-13 is a blocking capacitor which prevents final-amplifier plate voltage from reaching the final-amplifier plate coil or the antenna. L-5, C-14, and C-15 form the final-amplifier plate tank circuit. The arrangement of these elements is such that a pi-section impedance-matching network is

obtained, with the result that the low impedance of the antenna transmission line is transformed to a higher impedance, thereby loading the final amplifier properly.

Referring to the audio section of the transmitter, the microphone is connected through its cord in series with the primary of microphone transformer T-1, current-limiting resistor R-14, and the battery. A-f currents are bypassed around R-14 and the battery by capacitor C-11. Induced secondary voltage in T-1 is applied to grids of modulators VT-4 and VT-5. Plates of VT-4 and VT-5 energize the primary of modulation transformer T-2. Plate and screen voltage is supplied to final amplifier VT-3 in series with the secondary of modulation transformer T-2. The a-f voltage produced in the secondary of T-2 by the modulator is in series with the d-c plate and screen voltage. This results in plate modulation of final amplifier VT-3.

The panel meter may be used to indicate either grid current or plate current in the final amplifier, the selection being made by means of a small toggle switch SW-1 mounted behind the panel to the right of the meter. Meter ranges are 0-10 ma for grid current, and 0-100 ma for plate current. After installation the switch is left so that the meter indicates plate current. R-11 is the 100-ma shunt for plate current. R-12 provides a return path for grid current when panel meter is switched to measure plate current, and has sufficiently high resistance to prevent objectionable shunting action on the meter.

1.3 Power Supply Circuit

Filaments of all tubes are heated directly from the battery. Plate supply is obtained from the Power-Supply Unit.

The Power-Supply Unit contains two vibrator-type plate-supply units and a filter. Referring to Fig. 2.62, the Schematic Diagram, it is seen that primary voltage is supplied to the vibrators through contacts on Relay-201. Vibrator outputs are connected in parallel through their respective filter chokes, L-201 and L-202. C-201, C-202, and C-203 are filter capacitors.

The Power-Supply Unit is identical with that supplied in the Type K, Model AA, Radiophone.

Battery drains are listed in Table 2.

Table 2

Battery Drains

Transmitter Filaments only	2.5 Amperes
Transmitter Operating	14 to 15 Amperes (Varies with Modulation)

1.4 Switching Circuits

Switching circuits in the Type KU-T, Model A, are similar to those in the transmitter of the Type K Radiophone, Models A and AA. See Sec. C13.9, "Type K, Model A", Item 1.4, "Switching Circuits".

1.5 Other Features

1.51 Antenna

The antenna is a quarter-wave vertical collapsible fishpole.

2.0 Adjustment and Repair, General

The following tools and equipment are needed for repair and adjustment of the Type KU-T, Model A, Transmitter:

(a) Usual assortment of bench and hand tools.
(b) Tube Checker.
(c) High-resistance d-c voltmeter, 1000 or more ohms per volt. A 20,000-ohms-per-volt instrument is preferred. Scales needed: 0-10, 0-250, 0-1000 volts.
(d) A-c voltmeter, copper-oxide-rectifier type, 1000 ohms per volt. Scales needed: 0-2.5, 0-10, 0-50, 0-1000 volts.
(e) Ohmmeter.

Note: Items (c), (d), and (e) may be obtained in a single combination instrument.

(f) Cathode-ray oscilloscope.
(g) USFS Type A Test Set.

If the transmitter fails to operate, the following procedure should be used to locate the trouble:

(1) See that cable terminals engage firmly in their receptacles, and that connections on power-supply terminal strip are tight.

(2) See that storage battery is well charged. A hydrometer will indicate a specific gravity of 1.280 for a fully charged battery, 1.250 for a half charge, and 1.220 for a discharged battery.

(3) Check voltage at the "A HOT" terminal on the power-supply terminal strip. Measurement should be made with both receiver and transmitter turned on, and with "push-to-talk" switch pressed. Voltage should be at least 5.7 volts with vehicle motor shut down. If it is less than this amount, voltage should also be measured at the terminals of the battery, with the same load. This will indicate whether the cause of the abnormally low voltage is the condition of the battery, or excessive drop in battery leads and connections. Inspect ground connections. Make necessary repairs or replacements to restore normal voltage at "A HOT" terminal on power-supply terminal strip.

(4) Inspect antenna and antenna transmission line. See that base insulator is clean, and that connections are firm.

2.1 Transmitter Data

If the foregoing tests do not clear the trouble the next step is a series of tests which will indicate whether the trouble is in the power supply, r-f section, modulator, or antenna. Having thus localized the trouble, the search for faulty components may be concentrated within the section which is not performing properly.

2.11 Preliminary Tests to Localize Trouble

Although the Types KU-T and K Transmitters operate on widely different frequencies, the functional arrangements of the various components are similar in the two transmitters. Thus the text in Sec. C13.9, "Type K, Model A", Item 2.11, "Preliminary Tests to Localize Trouble" is applicable to the Type KU T Transmitter, with minor differences which will be evident to the technician. For instance, symptoms indicating improper oscillator performance in the Type K may indicate improper oscillator or doubler performance, or both, in the Type KU-T.

Where the above-mentioned text directs the technician to connect the antenna to the transmitter, it is preferable to use a dummy antenna, to avoid causing interference during tune-up operations. See Sec. C12.403, "Dummy Antennas for Adjusting Transmitters".

Normal off-resonance final amplifier plate current in the Type KU-T is about 70 ma.

2.12 R-F Section, Adjustment and Repair

(1) Measure tube-element voltages. For tube-socket diagrams, see Fig. 2.63, the Photodiagram. All filaments should have the full battery voltage applied to their terminals, and this should not decrease greatly when the microphone switch is pressed. Normal voltages of other elements should be approximately as listed in Table 3. Screen and cathode voltage on final amplifier VT-3, and cathode voltage on doubler VT-2 will be somewhat dependent upon adjustments, the values shown being normal for correct adjustment.

Table 3

Normal Tube-Element Voltages (Measured to Ground)

(a) VT-1 Oscillator (Type 89)

Plate (Junction of R-2 and C-2)	275
Screen	135
Suppressor	35

(b) VT-2 Doubler (Type 89)

Plate (Junction of R-5 and C-6)	275
Screen	135
Suppressor	35
Cathode Bias	Depends upon excitation from oscillator and resulting plate current. Typical value, 20 volts.

(c) VT-3 Final Amplifier (Type 807)

Plate (measured on meter side of RFC-3)	275
Screen	130
Cathode Bias	Depends upon loading and resulting plate current. Typical value, 16 volts.

(d) VT-4 and VT-5 Modulators (Types 6V6)

Plate	275
Screen	290
Cathode Bias	17.5 - 20°

°Varies with modulation.

(2) The next step is the re-tuning of the oscillator and doubler stages. See that the crystal is inserted so that the "GRID" pin engages the "GRID" terminal on the crystal socket. Turn meter switch SW-1 to "GRID", for which position the panel meter range is 0-10 ma. Unless there is a faulty component, or oscillator or doubler tuning is very far from normal, the meter should indicate some current when the microphone switch is pressed. Retune oscillator-plate-tuning capacitor C-2 and doubler-plate-tuning capacitor C-6 for maximum final-amplifier-grid current. Usually it is not necessary to readjust oscillator-cathode-tuning capacitor C-1, because this adjustment is not critical, and oscillator performance would be impaired only by a relatively large misadjustment of C-1. If final amplifier-grid current is between 3 and 4 ma after the above adjustments, the procedure of the following paragraphs (3) to (5) inclusive, may be omitted.

(3) If, during the procedure of the foregoing paragraph (2), no final-amplifier-grid current was observed before or during the capacitor adjustments, the oscillator may not be operating. Improper oscillator performance may be caused by a faulty component, or by a gross misadjustment of oscillator-cathode-tuning capacitor C-1. To check the latter possibility, switch the d-c voltmeter to the 0-250 volt scale and connect prods across oscillator grid leak R-1. Tune C-1 for maximum meter deflection. The presence of the deflection indicates that the oscillator is operating. Alternately press and release the microphone switch several times to make sure the oscillator starts reliably. If there is a

tendency toward unreliable starting, inspect crystal and crystal holder. Clean crystal, and see that holder does not bind edges of crystal.

If no meter deflection is obtained, indicating that the oscillator is not operating, try a new oscillator tube. Examine oscillator circuit for faulty components.

(4) The next step is the tuning of the oscillator-plate-tank capacitor C-2. Switch the d-c voltmeter to the 0-50 volt scale and connect prods across doubler-cathode resistor R-4. Press the microphone switch and tune C-2 for maximum deflection. The deflection rise being sought is rather small; under typical conditions the metcr will read about 17 volts while C-2 is tuned over most of its range. This reading will increase sharply to about 19 volts when the oscillator-plate circuit is resonated.

(5) Doubler-plate-tuning capacitor C-6 may now be resonated for maximum final-amplifier-grid current. A slight readjustment of oscillator-plate-tuning capacitor C-2, and a subsequent readjustment of doubler-plate-tuning capacitor C-6 may increase final-amplifier-grid current somewhat.

(6) The next step is the adjustment of "R" and "L" controls for resonance and proper loading in the final-amplifier-plate circuit. To make this adjustment, see that meter switch SW-1 is turned to "PLATE", for which position it will have a range of 0-100 ma. Press microphone switch SW-3, and tune "R" adjustment for minimum final-amplifier-plate current, as indicated by panel meter. If this minimum current is less than 40-50 ma, turn "L" control so as to reduce capacitance of C-15, and again tune "R" for minimum panel meter indication; if more than 40-50 ma, turn "L" control so as to increase C-15 capacitance, and repeat adjustment of "R" control for minimum panel-meter indication. This series of alternate adjustments of "L" and "R" controls is repeated until panel meter indicates 40-50 ma when "R" is tuned for minimum current. The adjustment of the "R" control is the last adjustment made.

(7) Turn meter switch SW-1 to "GRID". Press microphone switch and carefully retune oscillator-cathode-tuning capacitor C-1, oscillator-plate-tuning capacitor C-2, and doubler-plate-tuning capacitor C-6 for maximum final-amplifier-grid current. This current should then be 3 to 4 ma. Return meter switch SW-1 to "PLATE".

(8) Detune only the "R" control, and observe maximum off-resonance plate current. If this current is less than about 70 ma, the need for a new final-amplifier tube is indicated. This of course presupposes that all previous checks on plate voltage and excitation have been made. Return "R" control for minimum plate current.

(9) If a dummy lamp load has been used during the foregoing adjustments, it may have been observed that the power output is greater when the

excitation is slightly reduced by detuning C-1, C-2, or C-6 than it is with proper maximum excitation. This condition is entirely normal, and is due to the fact final-amplifier grid bias increases, and therefore plate current decreases, with increasing excitation.

(10) If the initial adjustment of the transmitter was poor, it will be well to re-check the tube-element voltages with Table 3.

(11) Before replacing transmitter in its cabinet, make sure meter switch SW-1 has been returned to "PLATE".

(12) If the foregoing adjustments have been made with a dummy antenna, it will be necessary to readjust "R" and "L" controls according to the procedure of foregoing paragraph (6), with the regular antenna connected.

2.13 Modulator, Adjustment and Repair

The modulator in the Type KU-T, Model A, is identical with that in the Type K, Models A and AA. See Sec. C13.9, "Type K, Model A", Item 2.13, "Modulator, Adjustment and Repair".

2.3 Power Supply Data

The Power Supply Unit in the Type KU-T, Model A, is identical with that in the Type K, Model AA. See Sec. C13.9, "Type K, Model A", Item 2.3, "Power Supply Data".

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Oscillator cathode tuning	240 mmf variable mica padder	Mallory	CTX-955
C2	Oscillator plate tuning	25 mmf variable	Hammarlund	APC Type, 25 mmf. special 0.030"-spaced, cadmium plated.
C3	Oscillator plate-return bypass	.001 mfd mica	Solar	MHX-1027
C4	Doubler grid blocking	.00005 mfd mica	(Aerovox (Solar	1467) MW-1210)
C5	Doubler cathode bypass	.001 mfd mica	(Aerovox (Solar	1467) MW-1227)
C6	Doubler plate tuning	25 mmf variable	Hammarlund	APC Type, 25 mmf. special 0.030"-spaced, cadmium plated.
C7	Doubler plate-return bypass	.001 mfd mica	(Aerovox (Solar	1467) MW-1227)
C8	Final-amplifier grid-return bypass	.001 mfd mica	(Aerovox (Solar	1467) MW-1227)
C9	Final-amplifier cathode bypass	.001 mfd mica	(Aerovox (Solar	1467) MW-1227)
C10	Final-amplifier screen bypass	.001 mfd mica	(Aerovox (Solar	1467) MW-1227)
C11	Microphone supply bypass	30 mfd 150-v.) electrolytic)	Mallory	FPD-211
C12	Modulator cathode bypass	30 mfd 150-v.) electrolytic)		
C13	Final-amplifier plate blocking	.0005 mfd mica 2000-v.test	Solar	MHX-1022

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C14	Final-amplifier resonating	25 mmf variable	Hammarlund	APC type, 25 mmf. special 0.030"-spaced, cadmium plated
C15	Final amplifier loading	140 mmf variable	Hammarlund	APC-140, cadmium plated
C16	Oscillator and doubler screen bypass	.001 mmf mica	Solar	MHX-1027
C17	Oscillator and doubler suppressor bypass	.001 mmf mica	Solar	MHX-1027
C201	Ripple filter	8 mfd 450 W.V.)	Mallory or Solar	CM-175 LG5-888
C202	Ripple filter	8 mfd 450 W.V.)		
C203	Ripple Filter	8 mfd 450 W.V.)		
C204	Vibrator buffer	.005 mfd 1600-v. oil filled	Mallory	A-40980-1*
C205	R-f filter	.05 mfd 600-v. paper	Mallory	TP-415*
C206	R-f filter	.5 mfd 100-v. paper	Mallory	RF-481*

* Part of Mallory type VP-552 vibrapack.

2.52 Inductors

L1	Oscillator cathode	20 turns #24 enameled wire, close-wound on National type XR-3 form.
L2	Oscillator plate	15 turns #22 enameled wire, space-wound on Amphenol type 24 form, threaded 16 turns per inch, threads cut 0.015" deep.
L3	Doubler plate	7 turns #22 enameled wire, space-wound on Amphenol type 24 form, threaded 10 turns per inch, threads cut 0.015" deep.
L4	Final-amplifier grid	2-3/4 turns #26 enameled wire, space-wound on same form with L3. L4 is wound on threads cut between grounded-end turns of L3, threads cut 0.015" deep.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L5	Final amplifier plate	7 turns #18 enameled wire, space-wound on National type XR-2 form, threaded 7 turns per inch, threads cut 0.015" deep.		
L201	Filter choke	5 henries, 80 ma	Thordarson	T-57 C 51
L202	Filter choke	5 henries, 80 ma	Thordarson	T-57 C 51
L203	R-f filter		Mallory	RF-583*
L204	R-f filter		Mallory	A-40919-1*
RFC-1	Oscillator grid-return choke	2.5 mh, 125 ma	(Hammarlund (National (Coto	CH-X) R-100) CI-11)

*Part of Mallory type VP-552 vibrator.

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
RFC-2	Doubler grid-return choke	2.5 mh 125 ma	(Hammarlund (National (Coto	CH-X) R-100) CI-11)
RFC-3	Final-amplifier plate choke		Ohmite	Z-2

2.53 Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R1	Oscillator grid leak	50,000 ohms, 1 watt	IRC	BT-1
R2	Oscillator plate-return isolating	1,000 " 1 "	IRC	BT-1
R3	Doubler grid leak	50,000 " 1 "	IRC	BT-1
R4	Doubler cathode	1,000 " 1 "	IRC	BT-1
R5	Doubler plate-return isolating	1,000 " 1 "	IRC	BT-1
R6	Final-amplifier grid leak	10,000 " 1 "	IRC	BT-1
R7	Final-amplifier cathode	250 " 2 "	IRC	BW-2
R8	Screen and suppressor voltage divider	10,000 " 2 "	IRC	BT-2

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R9	Screen and suppressor voltage divider	12,000 ohms,1 watt	IRC	BT-1
R10	Final-amplifier screen dropping	15,000 " 2 "	IRC	BT-2
R11	Final-amplifier plate meter shunt	Special		
R12	Final-amplifier grid meter shunt	500 ohms,1 watt	IRC	BT-1
R13	Modulator cathode	250 " 10 "	Ohmite	Brown-Devil
R14	Microphone dropping	100 " ½ "	IRC	BW-½
R15	Screen and suppressor voltage divider	5,000 " 1 "	IRC	BT-1
R201	Capacitor discharge limiting	200 " 10 "	Ohmite	Brown-Devil
R202	Buffer capacitor series	5,000 " ½ "	(Mallory (IRC	A-40389-3 *) BT-½)

*Part of Mallory type VP-552 vibrapack.

2.54 Tubes

VT1	Oscillator	Sylvania, RCA	89
VT2	Doubler	Sylvania, RCA	89
VT3	Final amplifier	RCA	807
VT4	Modulator	Sylvania, RCA	6V6
VT5	Modulator	Sylvania, RCA	6V6

2.55 Transformers

T-1	Microphone	Phelps-Dodge	Inca 06985
T-2	Modulation	Phelps-Dodge	Inca 07021
T-201	Vibrapack power	Mallory	B-40966-1*

*Part of Mallory type VP-552 vibrapack

SYMBOL	COMPONENT	MANUFACTURER	TYPE
SW-1	Meter switch	Mallory	S-3
SW-2	Transmitter on-off	H & H	SPST toggle, with short nickel-plated handle
SW-3	Microphone "push-to-talk"		Integral with microphone
SW-201	Vibrapack voltage selector	Mallory	B-111202-1 *

2.57 Terminal Strips

TS-201	Vibrapack terminal strip	Mallory	A-40922-1 *

2.58 Power Supply

QUANTITY	COMPONENT	MANUFACTURER	TYPE
2	Vibrapack	Mallory	VP-552
2	Vibrators (1 for each Vibrapack)	Mallory	725 *

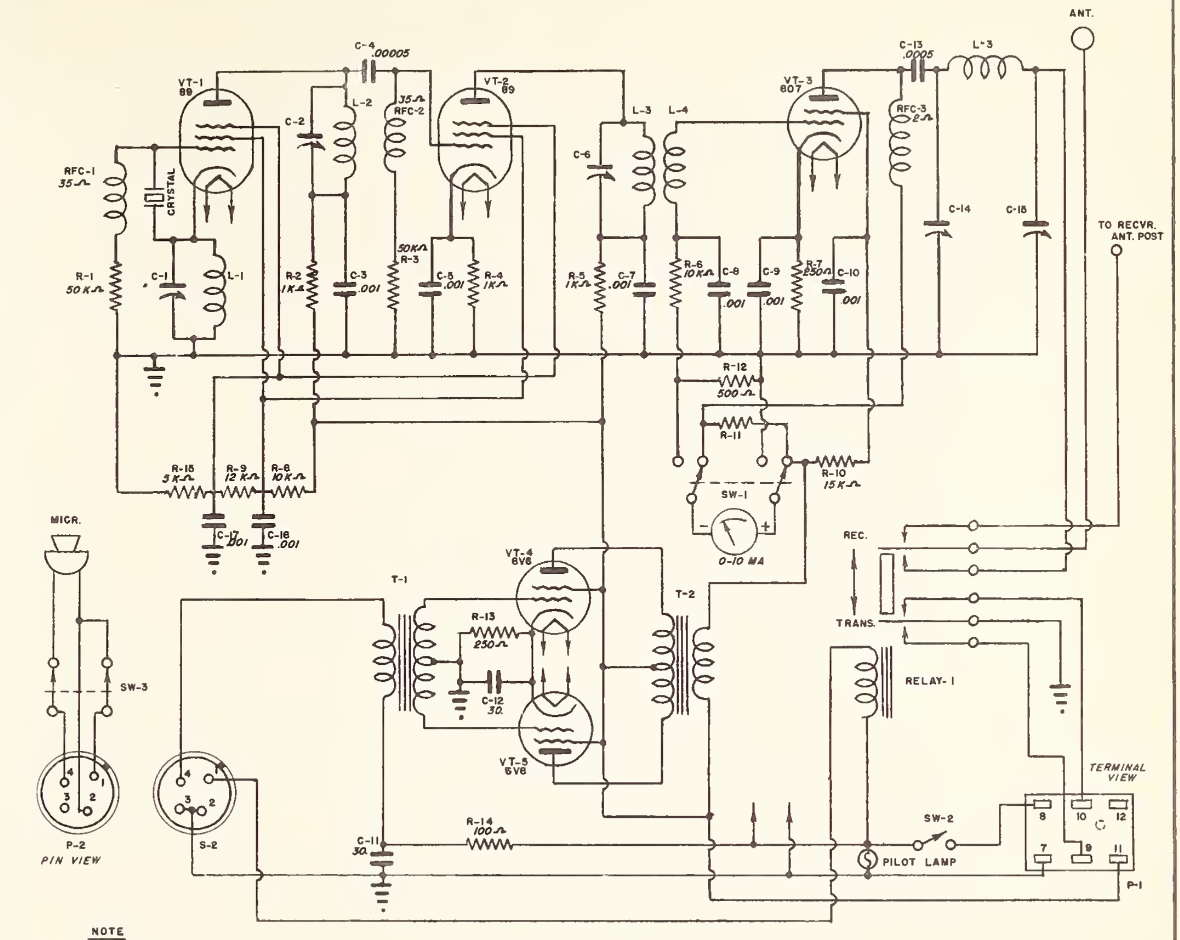
* Part of Mallory VP-552 Vibrapack.

2.59 Miscellaneous

QUANTITY	SYMBOL	COMPONENT	MANUFACTURER	TYPE
1	Crystal	Crystal (specify frequency) ground to exactly 1/6 of transmitter frequency.	Radio Specialty	V
1		Holder, crystal	Radio Specialty	V
1		Microphone	Kellogg	T-17
1		Cord, microphone, 3-conductor, flexible, rubber-covered, 5'	Belden	8453
1	S-2	Socket, microphone cord	Amphenol	PC4F
1	P-2	Plug, microphone cord	Amphenol	MC4M
1		Milliammeter, 0-10 ma. d-c with 0-100 scale	Simpson	Model 125-5 with 0-100 scale
1	Relay-1	Relay, send-receive	Leach	1027 with coil 354
1	Relay-201	Relay, power supply	Leach	1027 with coil 354

QUANTITY	SYMBOL	COMPONENT	MANUFACTURER	TYPE
1	P-1	Receptacle,power cable	Jones	P-6-AB-3/4"
1	S-1	Plug, power cable	Jones	S-6-CCT
1		Cable,power,4-conductor color-coded with braided covering, 5'	Lenz	Per Lenz shop order 89272, 4-conductor battery cable mfd.for U.S. Dept.Agri.,F.S.
2		Receptacles,antenna connector	Amphenol	80-CT
2		Plugs, Antenna connector	Amphenol	80-MT
1		Socket, pilot lamp	ARHCo	1724
1		Lamp, pilot	G.E.	Mazda 51
1		Cap, lamp,for pilot lamp	Western Electric	4F
2		Sockets, vibrator	Mallory	A-40921-1*
1		Socket,crystal holder,5-prong	Eby	12 B
1		Socket, 5-prong	Amphenol	RSS-5
2		Socket, 6-prong	Amphenol	SS-6
2		Sockets, octal	Amphenol	MIP-8
1		Lead, receiver voice coil, #16 flexible braided rubber covered, 10'	Belden	7718
2		Leads, battery, #8 flexible braided, rubber covered, 3', fitted with terminal lugs	Belden	7708
3		Clips, grid	National	24
2		Buttons, plug	Cinch	50628

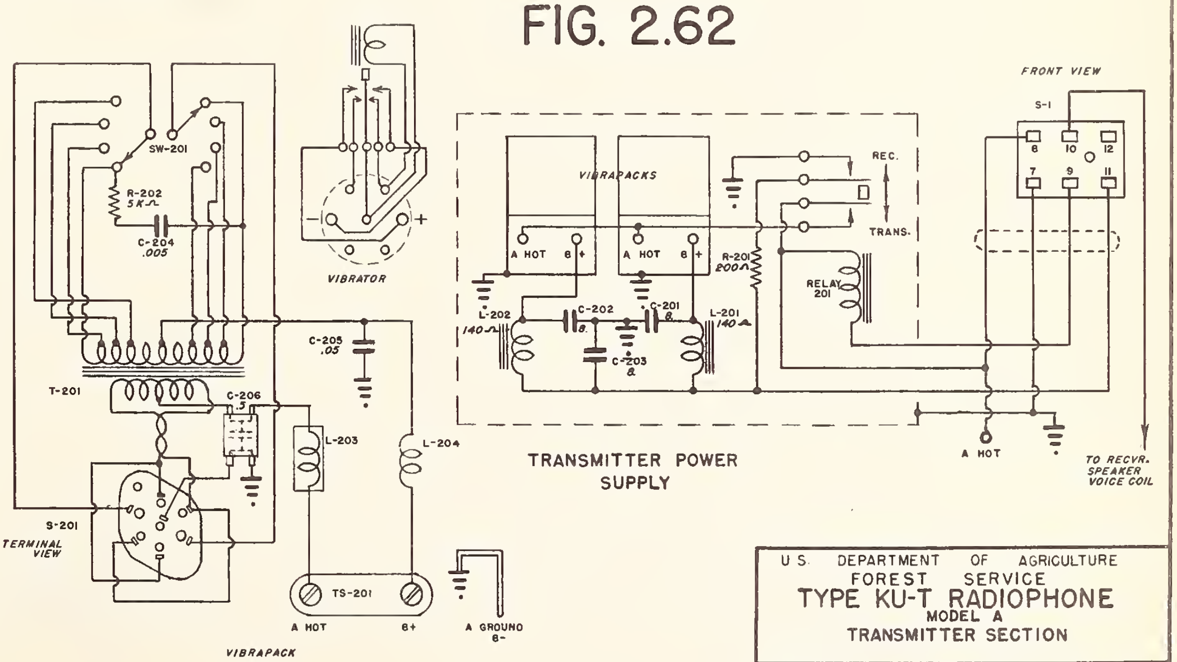
*Part of Mallory VP-552 vibrapack.



TRANSMITTER SECTION

NOTE
Ω = OHMS
KΩ = 1000 OHMS
MΩ = MEGOHMS

FIG. 2.62



U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE KU-T RADIOPHONE
MODEL A
TRANSMITTER SECTION

DRAWN BY G.B.C. CHECKED BY E.H.S. DATE APR. 25, 1941	USFS RADIO LAB DRWG KUT-A-21-B

FORM RL-3

C13.11 Service Data Sheets

Type KU-T

Model AA

No. 13 to __________

Redio Hdbk.
Added 11-23-42
No. 12

C13.11 Type KU-T, Model AA

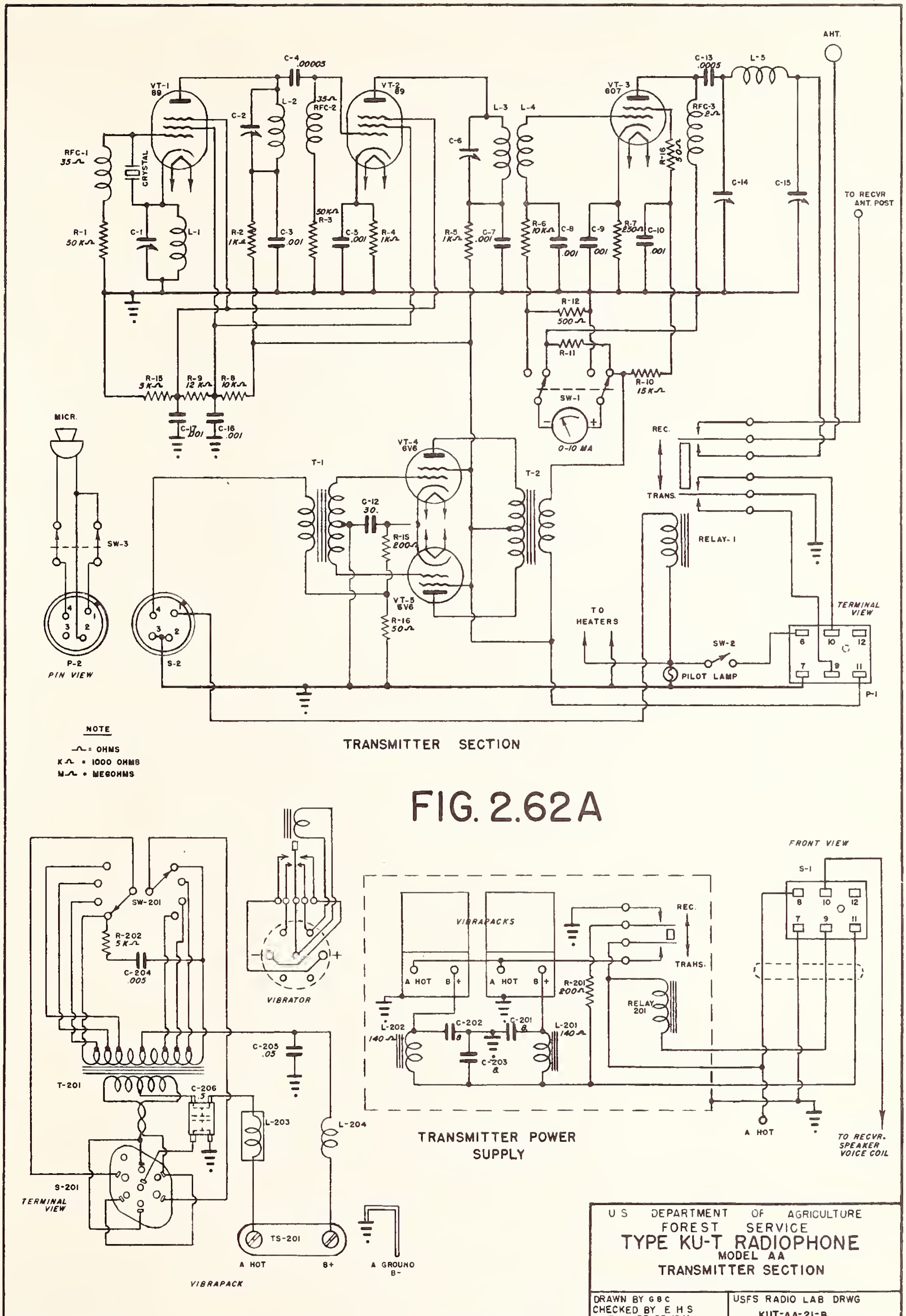
The KU-T, Model AA differs from Model A in that a screen suppressor resistor R-17, 50 ohms, was inserted in the screen grid lead of VT-3. The source of microphone supply was changed to eliminate vibrator-hash pickup in this circuit. R-13, R-14, and C-11 were deleted. R-15 and R-16 were added to the cathode circuit of VT-4 and VT-5, and the low end of T-1 was returned to the junction of these two resistors.

C13.11 Type KU-T, Model AA

Additional Parts List

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-15	Modulator Cathode	200 ohms, 2 watt	IRC	BT-2
R-16	Modulator Cathode	50 ohms, 1 watt	IRC	BW-1
R-17	Final-Amp. screen suppressor	50 ohms, $\frac{1}{2}$ watt	IRC	BW-$\frac{1}{2}$

see list #12 for corrections on these.



U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE KU-T RADIOPHONE
MODEL AA
TRANSMITTER SECTION

DRAWN BY G B C
CHECKED BY E H S
DATE APR. 25, 1941

USFS RADIO LAB DRWG
KUT-AA-21-B

RADIO HDBK.
ADDED 2-16-42
NO. 11

C13.12 Service Data Sheets

Type SX

(For Type SXA Radiophone Attachment, see Sec. C13.13)

Model	A	Nos.	1	to		Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.
Model		Nos.		to		Inc.

Radio Hdbk.
Added 6-10-41
No. 9

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0.0 Description, General

The Type SX is a stabilized portable ultra-high frequency radiophone having extreme flexibility in application. It serves scouts, smokechasers, and others requiring extreme portability. The addition of the type SXA radiophone attachment (see Sec. C13.13), which incorporates a loudspeaker, adapts the unit to semi-portable service in lookouts, ranger stations, and wherever standby operation is needed. The type SX in the portable form supersedes the Type S, and with the attachment supersedes the Type SV. The attachment is readily connected to or removed from the radiophone. No technical skill, additional wiring, or mechanical change is needed.

The Type SX transmits and receives voice only. The portable unit weighs 10 pounds, and has a rated working range of about 50 miles over optical paths. However, with low antennas and over level terrain, this may be reduced to 3 or 4 miles. A panel switch permits selection of any of 3 transmitting frequencies, any or all of which may be crystal controlled. The receiver is substantially noninterfering. A panel pushbutton provides means for setting the receiver on any of the 3 transmitter frequencies.

A kitbox is normally supplied when the attachment is ordered with the radiophone. This has compartments for storing the radiophone, radiophone attachment, heavy-duty batteries, heavy-duty-battery cable, Type J antenna, and halyards.

0.1 Electrical Specifications

Frequency Range	32 to 39 Mc
Transmitter Frequencies	3
Transmitter Frequency Control	Crystal (Optional)
Power Output	1/4 Watt
Distance Range	Optical Path
Type Operation	Simplex Voice (Push-to-talk)
Power Supply	Dry Batteries
Tube Complement	1 Type 1LE3 Oscillator 1 Type 1Q5GT Final Amplifier 1 Type 1Q5GT Modulator 1 Type 1LN5 R-F Amplifier 1 Type 1LE3 Detector 1 Type 1LN5 A-F Amplifier
Antenna, Portable	Half-wave Wire

0.2 Physical Specifications

Type SX Radiophone Dimensions (Overall)	$13\frac{1}{2}$" long, $5\frac{1}{2}$" wide, 7" high
Type SX Radiophone weight, with portable batteries	10 pounds

1.0 Detailed Description

The transmitter and receiver occupy opposite sides of the chassis. Panel receptacles permit plug-in connections for battery and microphone-headset cables. Panel controls include the "ON-OFF" switch, receiver tuning knob, "PUSH-TO-TALK" switch, transmitter frequency-selector ("TRANS FREQ") knob, and "CALIBRATE RECVR" push button. Pressing the "CALIBRATE RECVR" button turns on the transmitter oscillator, permitting the operator to set the receiver approximately on the transmitter frequency.

Arrangement of components is shown on Fig. 2.63, the Photodiagram. Components may be identified by reference to 2.5, Parts List, and Fig. 2.62, the Schematic Diagram.

1.1 Transmitter Circuit

A type 1LE3 oscillator, optionally crystal-controlled, operates at one-half the assigned frequency. The oscillator output excites a type 1Q5GT doubler final amplifier, which is modulated by a type 1Q5GT modulator.

Referring to Fig. 2.62, the Schematic Diagram, it is seen that "TRANS FREQ" switch SW-3 selects the crystal, oscillator-plate-tuning capacitor, and final-amplifier-plate-tuning capacitor which correspond with the desired transmitter frequency. L-2, together with C-1, C-2, or C-3, form the plate circuit, and feedback is provided through inductive coupling between L-2 and L-1. As the crystal is used in the oscillator, it is equivalent to a series resonant circuit. If no crystal is used, a mica capacitor is substituted, and the resonant plate circuit becomes the frequency-determining element. R-1 is the grid leak.

C-5 is the final-amplifier-grid-blocking capacitor, and R-3 the grid leak. L-3, together with C-8, C-9, or C-10, forms the plate circuit. C-7 bypasses R-6 and the modulation transformer for r-f currents. R-5, bypassed by C-6, is the screen-voltage-dropping resistor.

R-2, R-4, and R-6 are resistors which carry oscillator-plate current, final-amplifier-grid current, and final-amplifier-plate current, respectively. Each of these currents may be measured by connecting a milliammeter across the appropriate resistor. To facilitate measurements, the resistors are wired to rear chassis socket S-3.

R-2 and R-6 are bypassed by C-4 and C-7, respectively.

The primary of T-1, the microphone transformer, is in series with the microphone, which is supplied from the "A" battery. Microphone bypass capacitor C-12 prevents the microphone from rectifying stray r-f currents and thereby producing audio feedback.

Secondary voltage of microphone transformer T-1 is applied to the grid of modulator VT-3, which energizes modulation auto-transformer T-2. The a-f voltage induced in the entire winding of T-2 is in series with the d-c voltage applied to the plate and screen of final-amplifier VT-2, resulting in plate modulation.

C-11, the antenna-coupling capacitor, serves as the loading adjustment.

1.2 Receiver Circuit

The receiver employs a type 1LN5 r-f amplifier, a type 1LE3 self-quenching super-regenerative detector, and a type 1LN5 a-f amplifier.

C-101 couples signal energy from the antenna to the resonant input circuit consisting of L-101 and C-102. R-101, bypassed by C-105, maintains proper bias on VT-101.

R-f amplifier output voltage is coupled through C-107 to the resonant input circuit of detector VT-102. This circuit consists of L-102, C-103, and C-104. R-103 is the grid leak. RFC-102 isolates the plate for r-f current, and C-109 provides the necessary bypassing for quench-frequency currents.

R-105, R-106, C-110, and C-111 comprise a filter for attenuating quench-frequency voltage. The output of audio amplifier VT-105 is matched to the low-impedance headphones by transformer T-101.

1.3 Power Supply Circuit

1.5 "A" volts and 90 "B" volts are required. Modulator bias voltage is obtained from the drop across R-7, in series with the negative "B" lead.

Current drains are tabulated below:

Table I
Battery Drains

	Type SX only (Portable)		Type SX with Type SXA Attachment (Semi-portable)	
	"A" Battery	"B" Battery	"A" Battery	"B" Battery
Transmit	275 ma	21 ma	375 ma	26 ma
Receive	150	4	250	9

1.4 Switching Circuits

The function of the "TRANS FREQ" switch is discussed under 1.2, "Transmitter Circuit." "ON-OFF" switch SW-1 interrupts negative "A" and "B" battery leads. "PUSH TO TALK" switch SW-2 transfers antenna and A+ from the receiver to transmitter. "CALIBRATE RECVR" switch SW-4 applies filament voltage to the transmitter oscillator, VT-1, thereby starting the oscillator only and permitting the receiver to be set on the transmitter frequency.

1.5 Other Features

1.51 Antenna

The antenna for use with the portable type SX radiophone is a half-wave wire. Where the type SXA attachment is used, a USFS Type J antenna is employed. (See Sec. C9.203.)

2.0 Adjustment and Repair, General

The following tools and equipment are needed for adjusting and repairing the Type SX Radiophone:

(a) Usual complement of bench and hand tools.

(b) High resistance d-c voltmeter - 1000 or more ohms per volt. Scales, 0-2.5, 0-10, 0-50 ma.

(c) D-c milliammeters, ranges 0-1, 0-10, 0-10, 0-50 ma.

(d) Ohmmeter.

(e) Tube checker.

(f) Heterodyne frequency meter.

(g) Type A Test Set.

(h) Cathode-ray oscilloscope.

If the set fails to operate, make the following inspections:

(1) Test batteries.

(2) See that cable terminal plugs engage firmly in panel receptacles and batteries.

(3) Check tubes. This may be done by trying the tubes in another Type SX known to be in working order, or by substituting known good tubes in the set under observation.

Caution: Loctal tubes must be inserted with special care to prevent damage. First turn the tube without pressure until the guide pin indexes in the socket. Then push down without further turning force. If extreme care is not used, pins may start into socket holes incorrectly, resulting in breaking the air seal around the pin.

(4) Inspect radiophone for apparent physical damage.

2.1 Transmitter Data

If above tests do not restore operation, the procedure of Item 2.11 may be used to localize the trouble.

2.11 Preliminary Tests to Localize Trouble

(1) Test for presence of r-f output. If the Type SXA attachment is available, a normal r f voltmeter reading of about half scale indicates normal output, provided adjustments have been made according to directions. An alternate method is the use of the Type A Test Set. (See Sec. C12.301, Item 2.03.) If test shows no r-f output, see Item 2.12, "R-F Section, Adjustment and Repair," below.

(2) Check modulation. This may be done with the type A Test Set. (See Sec. C12.301, Item 2.04), or with the oscilloscope. (See Sec. C12.402, Item 2.0.) If r-f output is present but no modulation is indicated, see Item 2.13, "Modulator, Adjustment and Repair," below.

2.12 R-F Section, Adjustment and Repair

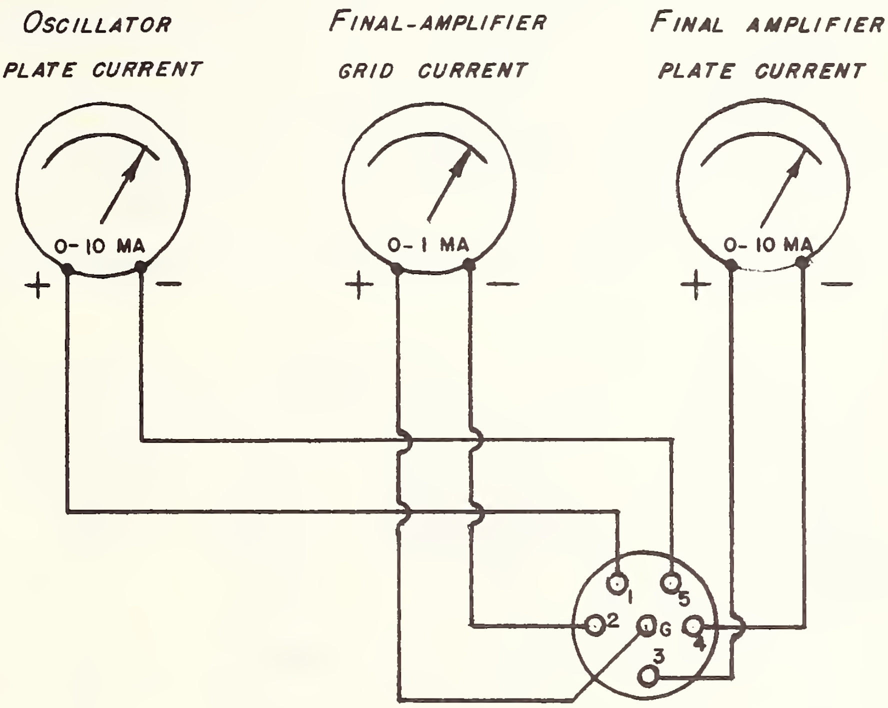
(3) Observe oscillator plate current, final-amplifier grid current, and final-amplifier plate current. Normal values for these currents are listed below:

Table 2
Normal Tube-Element Currents

Oscillator I_p (with crystal)	5 to 6 ma
Oscillator I_p (crystal replaced with capacitor)	3 to 4 ma
Final-amplifier I_g	0.4 to 0.5 ma
Final-amplifier I_p	5 ma (depends on adjustment of C-11)

A convenient assembly for observing these three currents simultaneously consists of two 0-10 milliammeters and one 0-1 milliammeter connected to an Amphenol type 24-6H plug, as shown in Fig. 1. The use of this plug is preferable to insertion of individual prods into S-3 socket holes, since an error

or the accidental touching of a prod to the chassis may damage the meter. If individual prods are used, remove battery-cable plug while inserting or removing prods. Check connections with Fig. 1.



AMPHENOL TYPE 24-6H PLUG
CORD-END VIEW
CORRESPONDS WITH REAR-CHASSIS
VIEW OF S-3

FIG. 1.

CURRENT METERING ASSEMBLY

If a milliammeter is not available, current may be measured by noting the voltage drop across the appropriate resistor. Oscillator or final-amplifier plate current in milliamperes is twice the voltage drop across R-2 or R-6, respectively. Final-amplifier grid current in milliamperes is one-fifth the voltage drop across R-4. A high-resistance voltmeter of at least 20,000 ohms per volt should be used.

(4) The departure from normal readings may suggest the location of the trouble. For instance, if both tubes have plate current, but final-amplifier grid current is zero, the oscillator is not functioning. Opens in d-c plate or filament circuits will be indicated by zero plate-current readings.

(5) Faulty oscillator performance, indicated by abnormally low or zero final-amplifier grid current, may result from improper transmitter tuning. The procedure for retuning a crystal-controlled channel differs slightly from that for a noncrystal channel and both procedures are outlined below. Before making these adjustments, it would be well to consult Table 3 below for locations of adjustable components associated with each of the 3 transmitter frequencies.

Table 3
Locations of Components Associated with Transmitter Channels

Position of Freq. Selector Switch SW-3	SW-3 Knob Points To	Crystal Socket	Oscillator Plate Capacitor (Variable Air)	Final-Amp. Plate Capacitor (Variable Mica)
Left	Red	Front	Left	Left
Center	White	Center	Center	Center
Right	Blue	Rear	Right	Right

2.121 Retuning Crystal-Controlled Channel

(6) Turn SW-3 to channel being tuned and see that crystal makes firm contact in corresponding socket. With meters inserted to read oscillator and final-amplifier plate currents, and final-amplifier grid current, press "push-to-talk" switch SW-2. Starting with the oscillator-plate tuning capacitor plates fully meshed, reduce capacitance to the exact point where final-amplifier-grid current first starts. It is important to approach this point from the fully-meshed condition. Oscillator plate current should be approximately 5 ma and final-amplifier-grid current should be between 0.4 and 0.5 ma. If currents are appreciably less, try a new oscillator tube. For frequencies above 38 megacycles the final grid current will run slightly lower, being about 0.3 to 0.4 ma.

(7) With the antenna connected to its binding post, adjust final-amplifier-plate-tuning capacitor for minimum plate current. The minimum current obtainable by this variation depends upon the adjustment of C-11. Adjust C-11 so that the minimum final-amplifier-plate current is 5 ma.

(8) Detune final-amplifier-plate-tuning capacitor, and note off-resonance plate current. This should be between 7.5 and 8.5 ma. If it is appreciably below these values, try a new tube. Re-resonate the tuning capacitor.

2.122 Retuning Non-Crystal-Controlled Channel

(9) Insert terminals of a 250 mmf mica capacitor in the crystal socket corresponding with the desired channel. To assure a firm contact, capacitor terminals may be fitted with 0.125" plugs, similar to Amphenol type 71-1M. Turn SW-3 to desired channel.

(10) Using an accurately-calibrated heterodyne frequency meter, adjust the oscillator-plate-tuning capacitor so that oscillator frequency is exactly one-half the desired transmitter frequency. Oscillator plate current should be at least 3 ma, and final-amplifier-grid current between 0.4 and 0.5 ma. If currents are appreciably less, try a new oscillator tube.

(11) Adjust final-amplifier-plate-tuning capacitor for minimum plate current, noting current value.

(12) If not done previously, note off-resonance plate current as outlined in paragraph (8) above.

(13) Recheck oscillator frequency and make minor corrections as necessary.

2.123 Final Adjustment of Loading

(14) When all channels have been adjusted as outlined above, it will be found that final-amplifier-plate current varies somewhat as the transmitter is switched from one channel to another. This is a normal result of the variation in antenna characteristics with frequency.

Capacitor C-11 should now be adjusted so that 5 ma is the largest plate current obtained on any of the 3 channels, when C-8, C-9, and C-10 are each adjusted for minimum plate current. Reducing capacitance of C-11 will decrease loading.

(15) When all above adjustments have been completed, the frequency of each non-crystal-controlled channel should be rechecked with the heterodyne frequency meter. Variations should be corrected.

(16) If the r-f section of the transmitter does not respond to the foregoing adjustments, search for a faulty component, such as a shorted or open coil, capacitor, or resistor. Inspect soldered joints and switch contacts.

2.13 Modulator, Adjustment and Repair

(17) Whistling into the microphone normally produces about 10 volts between the grid of VT-3 and ground, and 40 to 50 volts across the entire winding of T-2, as may be measured with a 1000-ohms-per-volt copper-oxide-type

voltmeter. A 0.5 mfd. capacitor should be connected in series with the volt meter to block d-c voltage. This simple test will suggest the general location of the trouble.

(18) Normal d-c resistance of the microphone, as measured between terminals 1 and 2 of plug P-2, varies between 20 and 100 ohms, and will fluctuate with sound intensity and with variation in position. While checking this resistance, flex the cable to make sure there is no intermittent open.

(19) An open circuit in microphone bypass capacitor C-12 will result in a tendency of the modulator to howl.

(20) Check d-c voltages in modulator. Microphone and filament voltages are each normally 1.5. Normal grid bias is approximately 5 volts. Normal plate and screen voltages are approximately equal to the "B" battery voltage.

(21) Tranformers may be examined for opens or other faults by comparing winding resistances with normal values marked on Fig. 2.62, the Schematic Diagram.

(22) After trouble has been repaired, modulation should be checked by one of the methods mentioned in paragraph (2) above. The oscilloscope method is preferable.

2.2 Receiver Data

If the receiver fails to operate properly, the following steps will help localize the trouble:

(1) When operating normally, the super-regenerative detector produces a hissing or rushing sound in the headset. Absence of this sound locates the trouble in components associated with or following the detector.

(2) If no characteristic hiss is heard, the audio amplifier may be tested by intermittently touching the prods of an ohmmeter between ground and the grid of audio-amplifier VT-103. Normal operation will be indicated by loud clicks, caused by bias shift.

(3) Test the headphones cord for an intermittent open. Normal headphones resistance (measured between pins 2 and 3 on microphone-headset plug P-2) is 25 ohms.

(4) If the detector and following components are normal, the r-f amplifier may be tested by comparing reception with that of a receiver known to be in working order. The comparison should be made using the same signal source and antenna for both receivers. The use of too strong a signal should be avoided. A Type A Test Set operating in an adjacent room as a modulated oscillator (see Sec. C12.301, Item 1.3) produces a satisfactory test signal.

(5) When trouble has been localized, components associated with the faulty portion of the receiver should be examined. All tube filaments should have full "A" battery voltage applied, and plates and screens of VT-101 and VT-103 should have practically full "B" battery voltage. Plate voltage on detector VT-102 is about 60 volts (assuming 90 "B" volts) measured across C-109. This measurement will be indicated accurately only by a high-resistance voltmeter (20,000 or more ohms per volt).

2.21 Receiver Alignment

(6) The tracking of the detector and r-f amplifier tuned circuits is aligned at the factory, and should hold its adjustment under any normal use conditions. Should realignment become necessary, due for instance to replacement of a damaged coil or capacitor, the following procedure should be used. This adjustment should be undertaken only if necessary, and only by a competent technician.

(7) Set knob so pointer indicates zero with tuning-capacitor plates fully meshed.

(8) Antenna must be connected during following alignment operations.

(9) Note dial reading when detector tuned circuit resonates at 39 Mc. For method of measuring resonant frequency, see Sec. C12.301, Item 2.05. If 39 Mc resonance of detector-tuned circuit does not occur within dial reading limits of 80 to 100, bring it within this range by adjusting the number of turns on coil L-102.

(10) Note dial reading when detector tuned circuit resonates at 32 Mc. If 32 Mc resonance of detector-tuned circuit does not occur within dial reading limits of 0 and 20, bring it within these limits by carefully bending plates of rear sections of the tuning capacitor. To decrease the dial reading for resonance at a given frequency, bend plates so as to reduce capacitance.

Caution: Rotor plates are fastened to shaft only with solder, and will not stand repeated back-and-forth bending. It is essential to make adjustments carefully and in small amounts. After bending plates, make sure spacing is adequate to prevent contact between rotor and stator plates.

(11) With tuning capacitor set so detector-tuned circuit resonates at 39 Mc, measure resonant frequency of r-f amplifier-tuned input circuit, consisting of L-101 and C-102. If resonant frequencies of r-f input circuit and detector-tuned circuit are not the same, they should be brought into agreement by adjusting the inductance of L-101. This is done by manipulating the position of the loop at the end of the coil.

(12) With detector-tuned circuit resonated at 32 Mc, measure resonant frequency of r f amplifier input circuit. If it is not the same as that of the detector input circuit, it should be brought into agreement by bending plates of the front section of the tuning capacitor. To increase resonant frequency for a given dial setting, bend plates so as to reduce capacitance.

See "Caution" note in paragraph (9) above.

2.5 Parts List

2.51 Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C1	Oscillator plate tuning	25 mmf variable air	Hammarlund	APC-25
C2	Oscillator plate tuning	25 mmf variable air	Hammarlund	APC-25
C3	Oscillator plate tuning	25 mmf variable air	Hammarlund	APC-25
C4	Oscillator plate return bypass	.0005 mf mica	(Aerovox (Solar	1466) MT-1322)
C5	Final amplifier grid blocking	.0005 mf mica	(Aerovox (Solar	1466) MT-1322)
C6	Final amplifier screen bypass	.0005 mf mica	(Aerovox (Solar	1466) MT-1322)
C7	Final amplifier plate return bypass	.0005 mf mica	(Aerovox (Solar	1468) MO-1422)
C8	Final amplifier plate tuning	3-30 mmf variable compression	Meissner	22-5255
C9	Final amplifier plate tuning	3-30 " "	"	22-5255
C10	Final amplifier plate tuning	3-30 " "	"	22-5255
C11	Antenna coupling	3-30 " "	"	22-5255
C12	Microphone bypass	.0005 mf mica	(Aerovox (Solar	1466) MT-1322)
C101	Antenna coupling	.000025 mf mica	(Aerovox (Solar	1468) MO-1406)
C102	R-f amplifier grid tuning)	3-gang variable	Hammarlund	Part No. 115-2596-101
C103	Detector tuning)			
C104	Detector tuning)			
C105	R-f amplifier grid	.0001 mf mica	(Aerovox (Solar	1468) MO-1416)
C106	R-f amplifier screen bypass	.001 mf mica	(Aerovox (Solar	1467) MW-1227)

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C107	R-f amplifier plate blocking	.0001 mf mica	(Aerovox (Solar	1468) MO-1416)
C108	Detector grid blocking	.00025 mf mica	(Aerovox (Solar	1468) MO-1419)
C109	Detector plate quench-frequency bypass	.004 mf mica	(Aerovox (Solar	1467) MW-1237)
C110	Quench-frequency filter	.0001 mf mica	(Aerovox (Solar	1468) MO-1416)
C111	Quench-frequency filter	.0005 mf mica	(Aerovox (Solar	1466) MT-1322)
C112	Audio amplifier grid blocking	.01 mf 600 v paper	Solar	S-0221

2.52 Inductors

L-1	Oscillator grid	$5\frac{1}{2}$ turns #26 enameled wire wound 40 turns per inch on same form with L-2, adjacent to ground end of L-2.
L-2	Oscillator plate	13 turns #26 enameled wire wound 40 turns per inch on National type XR-3 form.
L-3	Final amplifier plate	8 turns #22 enameled wire wound 20 turns per inch on National type XR-3 form, grooved 0.015" deep.
L-101	R-f amplifier grid	8 turns #24 enameled wire wound 28 turns per inch on National type PRE-1 form, grooved 0.015" deep.
L-102	Detector	22 turns #32 DSC wire close wound on 1/4" diameter x 15/16" long polystyrene rod.
RFC-101 RFC-102	R-f amplifier plate isolating) Detector plate choke)	3/8" long winding of #40 enameled wire, close wound on 3/8" diameter x 7/8" long polystyrene rod.

2.53 Resistors

R-1	Oscillator grid leak	5000 ohms, 1/2 watt	IRC	BT-$\frac{1}{2}$
R-2	Oscillator plate return isolating	500 " 1/2 "	IRC	BT-$\frac{1}{2}$

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-3	Final amplifier grid leak	.01 megohm, $\frac{1}{2}$ watt	IRC	BT-$\frac{1}{2}$
R-4	Final amplifier grid current metering	5000 ohms, $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-5	Final amplifier screen dropping	25000 " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-6	Final amplifier plate return isolating	500 " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-7	Bias	250 " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-101	R-f amplifier grid leak	1. megohm $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-102	R-f amplifier screen isolating	1000 ohms $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-103	Detector grid leak	0.1 megohm $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-104	Detector plate dropping	0.1 " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-105	Quench frequency filter	0.1 " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-106	" " "	0.25 " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$
R-107	Audio amplifier grid leak	10. " $\frac{1}{2}$ "	IRC	BT-$\frac{1}{2}$

2.54 Tubes

VT-1	Oscillator		Sylvania	1LE3
VT-2	Final amplifier		"	1Q5GT
VT-3	Modulator		"	1Q5GT
VT-101	R-f amplifier		"	1LN5
VT-102	Detector		"	1LE3
VT-103	Audio amplifier		"	1LN5

2.55 Transformers

T-1	Microphone		Phelps-Dodge	Inca 10128
T-2	Modulation		" "	" 10129
T-101	Receiver output		" "	" 10128

2.56 Switches

SYMBOL	COMPONENT	MANUFACTURER	TYPE
SW-1	On-off	H&H	DPST toggle, with short nickel-plated shank
SW-2	Transmit-receive	National	ACS-1
SW-3	Frequency selector	Mallory	3243-J
SW-4	"Calibrate receiver"	Mallory	B-114745

2.58 Batteries

Portable Batteries (for use in radiophone cabinet)

"A" Battery

	1 Eveready	742
or	1 Burgess	4F
or	1 General	4F1

"B" Battery

	1 Burgess	A60	
or	2 Burgess	A30	
or	2 General	V30A	
or	2 Burgess	Z30)	These are smaller-celled batteries
or	2 Eveready	738)	with correspondingly reduced life.
or	2 General	V30AA)	

Heavy-Duty Batteries (for use in kitbox)

"A" Battery

	2 Burgess	20FPI
or	2 General	12L-1L

"B" Battery

	2 Burgess	21308
or	2 Eveready	386
or	2 General	V30FL

2.59 Miscellaneous

SYMBOL	QUANTITY	COMPONENT	MANUFACTURER	TYPE
	1, 2, or 3	Crystals with holders		
	3	Sockets, crystal	Amphenol	54-2

SYMBOL	QUANTITY	COMPONENT	MANUFACTURER	TYPE
	1	Headphones, pair, 130-ohm with cord	Trimm	150 x 4
	1	Microphone	Western Electric	F-1, in special spun case with W.E. type P-24 7808 Phenol fibre grid
	1	Cord, microphone	Belden	Midrip
P-2	1	Plug, microphone cord	Jones	P-303-CCT
S-2	1	Socket, microphone cord	Jones	S-303-AB
	1	Cable, portable battery, 14"	Lenz	4-conductor battery cable per Lenz shop order 89304, mfd. for USDA Forest Service
	1	Connector, plug-in, "A" battery, for portable battery cable	Eby	30-2M
	2	Connectors, plug-in, "B" battery, for portable battery cable	Eby	30-3M
	1	Socket, portable battery cable	Jones	S-304-CCT
P-1	1	Plug, portable battery cable	"	P-304-AB
	1	Cable, heavy-duty battery, 7'	Lenz	4-conductor battery cable per Lenz shop order 89304, mfd. for USDA, Forest Service
	2	Connectors, plug-in "A" battery, for heavy-duty battery cable	Eby	30-2M

SYMBOL	QUANTITY	COMPONENT	MANUFACTURER	TYPE
	2	Connectors, plug-in "B" battery, for heavy-duty battery cable	Eby	30-3M
	1	Socket, heavy-duty battery cable	Jones	S-304-CCT
	4	Sockets, 8-prong loctal	Amphenol	88-8XT
	1	Socket, 8-prong octal	"	88-8
	1	Socket, 8-prong octal	"	54-8
	1	Socket, 5-prong miniature	"	78-5H
	1	Jack, for banana plug	General Radio	274-J
	1	Knob, tuning, with celluloid pointer	Crowe	590
	1	Knob, for SW-3	Eby	E-148
	1	Post, binding, marked "ANT"	XL	XL "ANT" pushpost
	1	Bushing, insulating	Bud	I-1909
	1	Panel	Regional Forester Portland, Oregon	For Type SX, Model A
	1	Instruction plate	" "	" " "
	1	Wire, portable-antenna, 13' 0" stranded, acetate covered	Lenz	Lenzac
	1	Halyard, portable-antenna, 15 ft., 2/0 trolling line		
	1	Insulator, portable-antenna	Johnson	32
	1	Antenna, Type J, copper-wire model	(See Sec. C9.203)	
	1	Halyard, Type J, antenna, 50 ft.	Connecticut Cordage	Charter oak braided mason line, Size No. 4

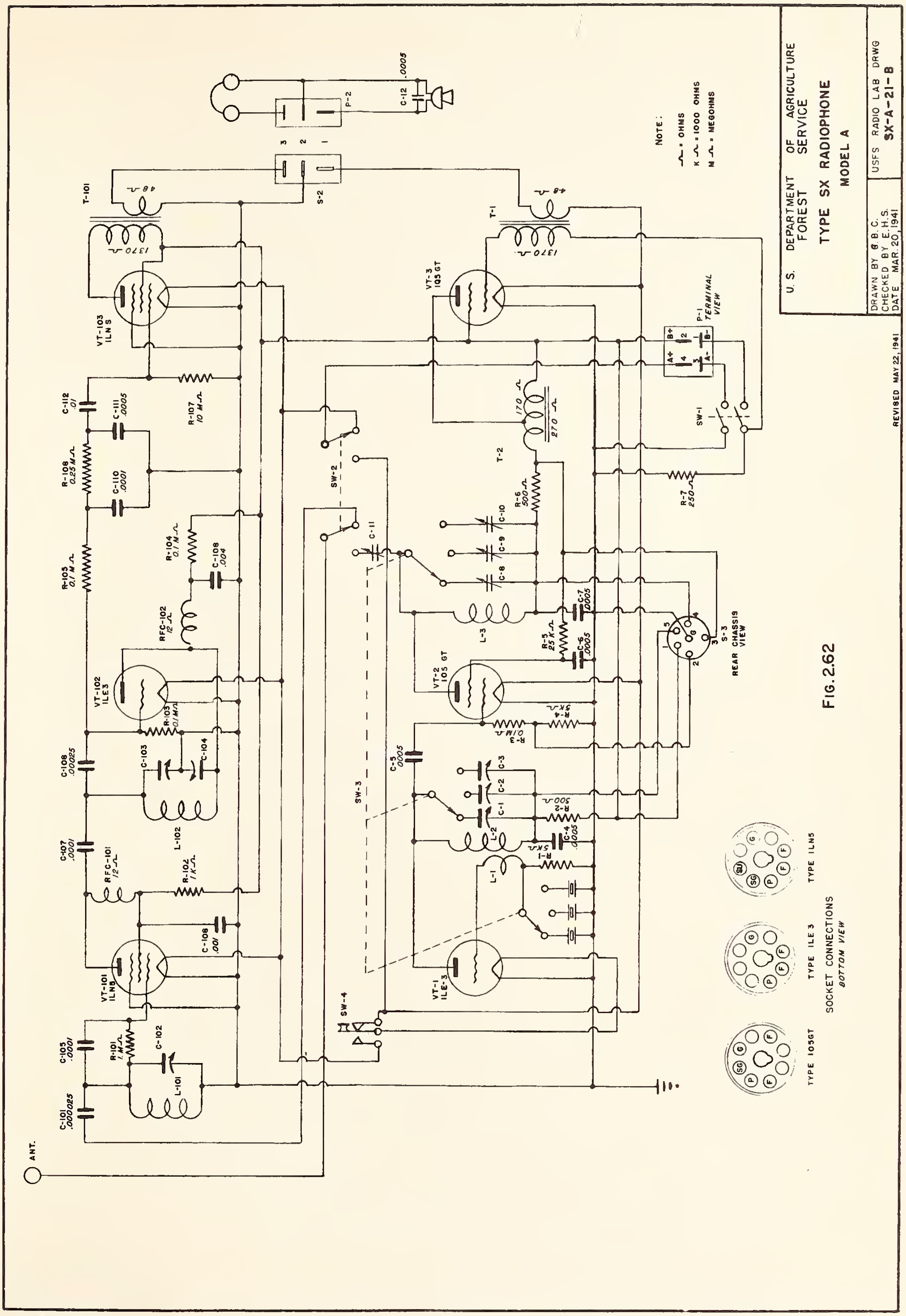

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE SX RADIOPHONE
MODEL A
DRAWN BY G. B. C.
CHECKED BY E. H. S.
DATE MAR. 20, 1941
USFS RADIO LAB DRWG
SX-A-21-B
FORM RL-4
REVISED MAY 22, 1941
NOTE:
Ω = OHMS
K Ω = 1000 OHMS
M Ω = MEGOHMS
SOCKET CONNECTIONS
BOTTOM VIEW
TYPE 1O5GT
TYPE 1LE3
TYPE 1LN5

FIG. 2.62

C13.13 Service Data Sheets

Type SXA

Model	A Nos.	1	to	Inc.
Model	Nos.		to	Inc.
Model	Nos.		to	Inc.
Model	Nos.		to	Inc.

Radio Hdbk.
Added 6-10-41
No. 9

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CONTENTS		Page
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1.3	Power Supply Circuit	3
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2.63	Photodiagram	7

Radio Hdbk.
Added 6-10-41
No. 9

0.0 General Description

The type SXA radiophone attachment is a companion unit for the type SX radiophone. Its use adapts the portable type SX to semi-portable service in lookouts, ranger stations, and wherever standby operation is needed.

The attachment contains an audio amplifier and speaker, thus permitting standby reception. A pi-section circuit matches the high antenna-terminal impedance of the type SX radiophone to the low impedance of the antenna lead. To simplify the adjusting of this circuit, provision is made for indication of r-f output on the panel meter. A switch permits the use of this meter also for measurement of "A" and "B" battery voltages.

The "ON-OFF" switch on the type SX controls the attachment. The USFS Type J antenna is normally used with this attachment (see Sec. C9.203).

0.2 Physical Specifications

Dimensions (overall)	$13\frac{1}{2}$" long x $5\frac{1}{2}$" wide x 7" high
Weight	6 lbs. 14 oz.
Kitbox dimensions	$9\frac{1}{2}$" high x 27" wide x 17" deep
Kitbox weight, including Type SX Radiophone, portable batteries, Type SXA Radiophone attachment, Type J antenna, halyards, heavy-duty battery cable, but without heavy duty batteries	53 lbs.
Weight of heavy-duty batteries	40 lbs.

1.0 Detailed Description

The low-impedance output from the receiver of the type SX is connected to the primary of step-up transformer T-102 through contacts 2 and 3 of stub-cord plug P-14. Secondary voltage of T-102 is applied to the grid of the type 1LA4 audio amplifier VT-104, through volume control R-121 and grid-blocking capacitor C-121. C-122 bypasses residual quench-frequency currents originating in the superregenerative detector. Grid bias is supplied partly from the bias cell, and partly from the voltage drop in R-7 (in the Type SX). Amplifier output is applied to the speaker through transformer T-103.

The high antenna-terminal impedance of the Type SX radiophone is matched to the low antenna-lead impedance by the pi-section circuit consisting of C-16, C-17, and L-7. To indicate r-f voltage on the antenna lead, a small amount of the r-f output current is rectified, and the resulting d.c. flows through the panel meter when meter switch SW-11 is in normal center position.

R-11 and R-12 are the 2-volt-range and 100-volt-range multipliers, respectively, for the panel meter. Meter switch SW-11 has springs which return

contacts to the center position.

1.3 Power Supply Circuit

Battery voltages and current drains are tabulated in Sec. C13.12, Item 1.3.

The battery cable socket engages with panel receptacle P-11, from which battery voltages reach the type SX through the stub cord, stub-cord socket S-12, and panel receptacle P-1 (on the Type SX).

A+ and B+ voltage is distributed in the attachment from terminals 4 and 2 of panel receptacle P-11. A- and B- leads reach the attachment through "ON-OFF" switch SW-1 (on the type SX) to the radiophone chassis, then through the flexible ground jumper.

Parts List

Capacitors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
C-15	Rectifier blocking	.0005 mf mica	(Aerovox (Solar	1468) MO-1422)
C-16	Impedance-matching-circuit resonating	17.5 mmf variable	Hammarlund	HF-15
C-17	Impedance-matching-circuit loading	100 mmf variable	Hammarlund	HF-100
C-121	A-f amplifier grid blocking	.01 mf 600-V paper	Solar	S-0221
C-122	A-f amplifier quench-frequency bypass	.0005 mf mica	(Aerovox (Solar	1468) MO-1422)
C-123	Plate battery bypass	12 mf 150-V electrolytic	Mallory	BB-22

Inductors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
L-7	Impedance-matching circuit	10 turns #14 enameled wire, self-supporting, 25/32" inside diameter x 1" long.		
RFC-105	Rectifier isolating		Ohmite	Z-1

Resistors

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-11	2-volt-range voltmeter multiplier	2000 ohms $\pm$ 5%, $\frac{1}{2}$-watt	IRC	BT-$\frac{1}{2}$

SYMBOL	COMPONENT	RATING	MANUFACTURER	TYPE
R-12	100-volt-range voltmeter multiplier	0.1 megohm $\pm$ 5%, $\frac{1}{2}$-watt	IRC	BT-$\frac{1}{2}$
R-121	Volume control	0.5 megohm variable	Centralab	N-103
R-122	A-f amplifier grid isolating	0.5 megohm, $\frac{1}{2}$-watt	IRC	BT-$\frac{1}{2}$
	Tubes			
VT-4	R-f output meter rectifier		Sylvania	1LE3
VT-104	A-f amplifier		"	1LA4
	Transformers			
T-102	A-f amplifier input		Phelps-Dodge	Inca-06985
T-103	A-f amplifier output		" "	Inca-F-63
	Switches			
SW-11	Meter switch	2-pole, 3-position with spring return to center position	Centralab	1455
	Miscellaneous			
	Loudspeaker, P-M, 5"		Jensen	PM-5-DS
	Meter, 0-1 ma, with special scale		Simpson	125
Bias Cell	Cell, bias, 1$\frac{1}{4}$-volt		Mallory	Grid bias cell, 1$\frac{1}{4}$ V.
	Cable, battery-interconnecting, 14"		Lenz	4-conductor battery cable, per Lenz shop order 89304, mfd. for USDA, Forest Service
S-12	Socket, battery-interconnecting-cable		Jones	S-304-CCT
P-11	Plug, battery-cable		Jones	P-304-AB

SYMBOL	COMPONENT	MANUFACTURER	TYPE
	Cable, audio-interconnecting, 14"	Lenz	3-conductor, similar to battery-interconnecting cable, except red wire deleted
P-14	Plug-audio-interconnecting cable	Jones	P-303-CCT
S-13	Socket, microphone cable	Jones	S-303-AB
	Sockets, 8-prong loctal (2 required)	Amphenol	88-8XT
	Plug, antenna-interconnecting lead	Amphenol	71-1S, yellow
	Bushing, panel, for antenna-interconnecting lead	Amphenol	78-1S, yellow
	Plug, ground-interconnecting lead	General Radio	274-P
	Knobs (2 required)	Bud	K-575
	Knob	Davies	1400
	Post, binding	X-L	XL pushpost "ANT"
	Post, binding	X-L	" " "GND"
	Bushing, panel, for "ANT" post	Bud	I-1909

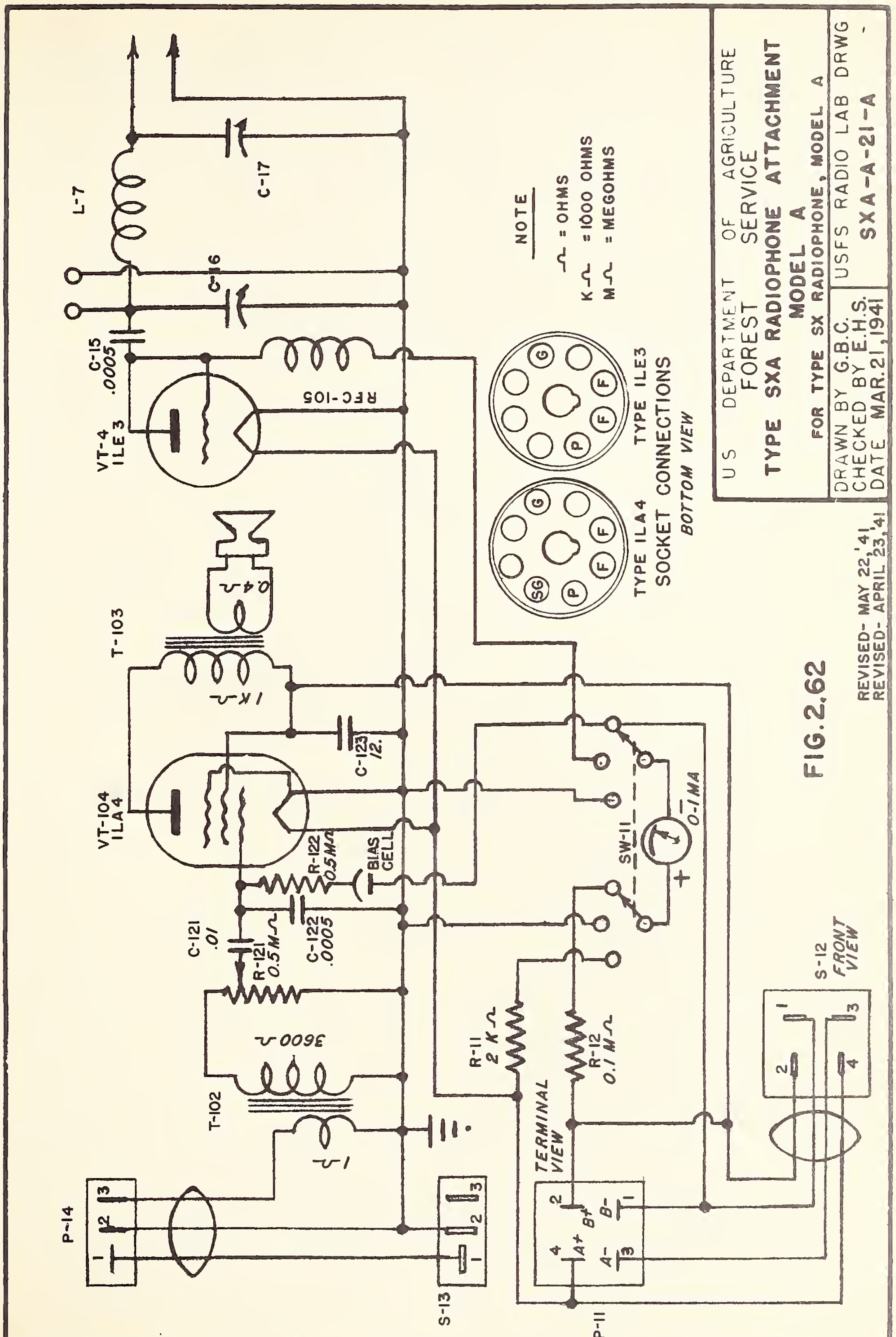
US DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TYPE SXA RADIOPHONE ATTACHMENT
MODEL A
FOR TYPE SX RADIOPHONE, MODEL A
DRAWN BY G.B.C.
CHECKED BY E.H.S.
DATE MAR. 21, 1941
USFS RADIO LAB DRWG
SXA-A-21-A
FORM RL-2
REVISED- MAY 22,'41
REVISED- APRIL 23,'41
NOTE
Ω = OHMS
KΩ = 1000 OHMS
MΩ = MEGOHMS
TYPE ILA4
TYPE ILE3
SOCKET CONNECTIONS
BOTTOM VIEW
L-7
C-17
C-16
C-15 .0005
VT-4 ILE3
RFC-105
T-103
0.4Ω
1KΩ
C-123 12.
VT-104 ILA4
R-122 0.5MΩ
BIAS CELL
C-121 .01
R-121 0.5MΩ
C-122 .0005
3600Ω
T-102
1Ω
SW-11
0-1MA
R-11 2KΩ
R-12 0.1MΩ
S-12 FRONT VIEW
TERMINAL VIEW
P-14
S-13
P-11
A+
B+
A-
B-

FIG.2.62

ADDRESSES OF MANUFACTURERS OF COMPONENTS OF U.S.F.S. RADIOPHONES

Aerovox	Aerovox Corporation	New Bedford, Mass.
Aladdin	Aladdin Radio Industries, Inc.	466 W. Superior St., Chicago, Illinois
Amphenol	American Phenolic Corp.	1250 W. Van Buren St., Chicago, Illinois
ARHCo	American Radio Hardware Co.	476 Broadway, New York, N. Y.
Automatic Electric	American Automatic Electric Sales Co.	1033 W. Van Buren St., Chicago, Illinois
Bassett	E. F. Johnson Co.	Waseca, Minn.
Belden	Belden Manufacturing Co.	Chicago, Illinois
Bliley	Bliley Electric Co.	Erie, Pa.
Bryant	The Bryant Electric Co.	Bridgeport, Conn.
Bud	Bud Radio, Inc.	Cleveland, Ohio
Burgess	Burgess Battery Co.	P. O. Box 121, Freeport, Illinois
Cardwell	The Allen D. Cardwell Mfg. Co.	Brooklyn, New York
Centralab	Centralab	900 E. Keefe Ave., Milwaukee, Wisconsin
Cinch	Cinch Manufacturing Corp.	2335 W. Van Buren St., Chicago, Illinois
Collyer	Collyer Insulated Wire Co.	Pawtucket, Rhode Island
CPI	Communication Products, Inc.	245 Custer Ave., Jersey City, N. J.
Cornell-Dubilier	Cornell-Dubilier Electric Co.	South Plainsfield, N. J.
Coto	Coto Coil Co., Inc.	Providence, R. I.
Crowe	Crowe Name Plate & Mfg. Co.	1749 Grace St., Chicago, Illinois
Eby	Hugh H. Eby, Inc.	2066 Hunting Park Ave., Philadelphia, Pa.

ADDRESSES OF MANUFACTURERS OF COMPONENTS OF U.S.F.S. RADIOPHONES (Cont.)

Edwards	Edwards & Co., Inc.	Norwalk, Conn.
Eveready	National Carbon Company	30 E. 42nd Street, New York, N. Y.
Fast	John E. Fast	Chicago, Illinois
Federal	Federal Anti Capacity Switch Corp.	Buffalo, New York
Galvin	Galvin Manufacturing Co.	4545 Augusta Blvd., Chicago, Illinois
General	General Dry Batteries, Inc.	13000 Athens Avenue, Cleveland, Ohio
G. E.	General Electric Co.	Schenectady, N. Y.
Girard-Hopkins	Girard-Hopkins Co.	Oakland, California
Guardian	Guardian Electric Mfg. Co.	1621-27 W. Walnut St., Chicago, Illinois
H & H	Arrow-Hart & Hegeman Electric Co.	Hartford, Conn.
Halldorson	The Halldorson Company	4500 Ravenswood Ave., Chicago, Illinois
Hammarlund	Hammarlund Manufacturing Co.	420-438 W. 33rd St., New York, N. Y.
Horton	The Horton Mfg. Co.	Bristol, Conn.
Hubble	Harvey Hubble, Inc.	Bridgeport, Conn.
Inca	Phelps-Dodge Copper Products Corp.	2375 E. 27th St., Los Angeles, Calif.
I.R.C.	International Resistance Co.	401 N. Broad St., Philadelphia, Pa.
Jensen	Jensen Radio Mfg. Co.	6601 S. Laramie Ave., Chicago, Ill.
Johnson	E. F. Johnson Co.	Waseco, Minnesota
Jones	Howard B. Jones	2300 Wabansia Avenue, Chicago, Illinois

ADDRESSES OF MANUFACTURERS OF COMPONENTS OF U.S.F.S. RADIOPHONES (Cont.)

Kellogg	Kellogg Switchboard & Supply Co.	1066 W. Adams St., Chicago, Illinois
Leach	Leach Relay Company	5915 Avalon Boulevard, Los Angeles, Calif.
Lenz	Lenz Electric Mfg. Co.	1751 Northwestern Ave., Chicago, Illinois
Littelfuse	Littelfuse Laboratories, Inc.	4238 Lincoln Avenue, Chicago, Illinois
Mallory	P. R. Mallory & Co.	Indianapolis, Indiana
Meissner	Meissner Manufacturing Co.	Mt. Carmel, Illinois
Miller	J. W. Miller Co.	5917 S. Main St., Los Angeles, Calif.
Motorola	Galvin Manufacturing Co.	4545 Augusta Blvd., Chicago, Illinois
Mueller	Mueller Electric Co.	1583 E. 31st St., Cleveland, Ohio
National	National Company	Malden, Massachusetts
National Carbon	National Carbon Company	New York, N. Y.
Ohmite	Ohmite Manufacturing Co.	4835 W. Flournoy St., Chicago, Illinois
Oxford	Oxford-Tartak Radio Corp.	915 W. Van Buren St., Chicago, Illinois
P & D	P & D Manufacturing Co.	Long Island City, N. Y.
Phelps-Dodge	Phelps-Dodge Copper Product Corp.	2375 E. 27th Ave., Los Angeles, Calif.
Pioneer	Pioneer Gen-E-Motor Corp.	466 W. Superior St., Chicago, Illinois
Premier	Oxford-Tartak Radio Corp.	915 W. Van Buren St., Chicago, Illinois
Radio Specialty	Radio Specialty Mfg. Co.	122 N. W. 10th Ave., Portland, Oregon

ADDRESSES OF MANUFACTURERS OF COMPONENTS OF U.S.F.S. RADIOPHONES (Cont.)

Raytheon	Raytheon Production Corp.	55 Chapel Street, Newton, Mass.
RCA	RCA Mfg. Co.	Camden, New Jersey
Sigma	Sigma Instruments, Inc.	Belmont, Mass.
Simpson	Simpson Electric Co.	5216 W. Kinzie St., Chicago, Illinois
Solar	Solar Manufacturing Corp.	Bayonne, N. J.
Spokane Radio	Spokane Radio, Inc.	611 1st Ave., Spokane, Wash.
Stromberg	Stromberg-Carlson Telephone Mfg. Co.	100 Carlson Rd., Rochester, N. Y.
Sylvania	Hygrade Sylvania Corp.	Emporium, Pennsylvania
Taylor	Taylor Tubes, Inc.	2341 Wabansia Ave., Chicago, Illinois
Thordarson	Thordarson Electric Mfg. Co.	500 W. Huron St., Chicago, Illinois
Trimm	Trimm Radio Mfg. Co.	1770 W. Berteau Ave., Chicago, Illinois
Triplett	The Triplett Electrical Instrument Co.	214 Harmony Drive, Bluffton, Ohio
Tungsol	Tung-Sol Radio Tubes, Inc.	Newark, New Jersey
Utah	Utah Radio Products Co.	820 Orleans St., Chicago, Illinois
Ward-Leonard	Ward-Leonard Electric Co.	Mt. Vernon, New York
Western Electric	Graybar Electric Co.	New York, N. Y.
Westinghouse	Westinghouse Electric & Mfg. Co.	E. Pittsburg, Pa.
Weston	Weston Electrical Instrument Corp.	589 Frelinghuysen Ave., Newark, N. J.
Wright Decoster	Wright DeCoster, Inc.	2233 University Ave., St. Paul, Minn.
X-L	X-L Radio Laboratories	420 Chicago Ave., Chicago, Illinois